TECHNICAL MANUAL

BAILEY BRIDGE

HEADQUARTERS, DEPARTMENT OF THE ARMY

AUGUST 1972

BAILEY BRIDGE

* This manual supersedes TM 5-277, 25 August 1966.

CHAPTER 1

BACKGROUND

Section I. INTRODUCTION

1–1. Purpose and Scope

a. This manual is a reference and guide for personnel responsible for designing and assembling the Bailey bridge. It covers the Panel Bridge, Bailey Type, M2, the extra wide Panel Bridge, Bailey Type, M3, and the cable reinforcement set for Panel Bridge, Bailey Type, M2. It is also a guide to the use of the bridge components and erection equipment for special constructions and applications.

b. The manual describes the component parts; the methods of loading, transporting, assembling, launching, maintaining, repairing, and dismantling the normal bridge and the cable reinforcement set; and the general use of the parts in special assemblies such as two-lane through type bridges, extra wide bridges, deck type bridges, railway bridges, assembly on piers, panel crib piers and towers, special launching methods, bridges on barges, and expedient assemblies.

1–2. Application

The material contained herein is applicable without modification to both nuclear and nonnuclear warfare.

1–3. Comments

Users of this manual are encouraged to submit recommended changes, additions, deletions, or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recomended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be prepared on DA Form 2028 (Recommended changes to Publication) and forwarded direct to the Commandant, US Army Engineer School, Fort Belvoir, Va. 22060.

Section II. DESCRIPTION AND USE

1–4. Description

a. Component Parts. The panel bridge is a through-type truss bridge, the roadway being carried between two main girders (fig 1–1—1–4). The trusses in each girder are formed from 10-foot panels pinned end to end. Transverse floor beams, called transoms, are clamped to the bottom chords of the trusses and support stringers and decking. Sway braces between the girders provide horizontal bracing; rakers between the trusses and transoms keep the trusses upright; and bracing frames and tie plates between the trusses provide lateral bracing within each girder. The bridge set contains 33 different items of bridge parts and 30 different items of erection equipment. These are described in detail in chapter 2. The bridge can be assembled by manpower alone.

b. Main Girders. The main girders on each side of the centerline of the bridge can be assembled from a single truss or from two or three trusses side by side, as shown in figure 1–5. For greater strength, a second story of panels can be added to the trusses. The upper stories are bolted to the top chord of the lower story. Double story bridges are shown in figure 1–6. For greatest strength, a third story is added as shown in figure 1–7. A single-truss, double- or triple-story bridge is never assembled because it would be unstable. All triple-story bridges with the deck in the bottom story are braced at the top by transoms and sway braces which are fastened to overhead bracing supports bolted to the top chords. Only the following types of truss assembly (fig 1–5, 1–6, and 1–7) can be used:

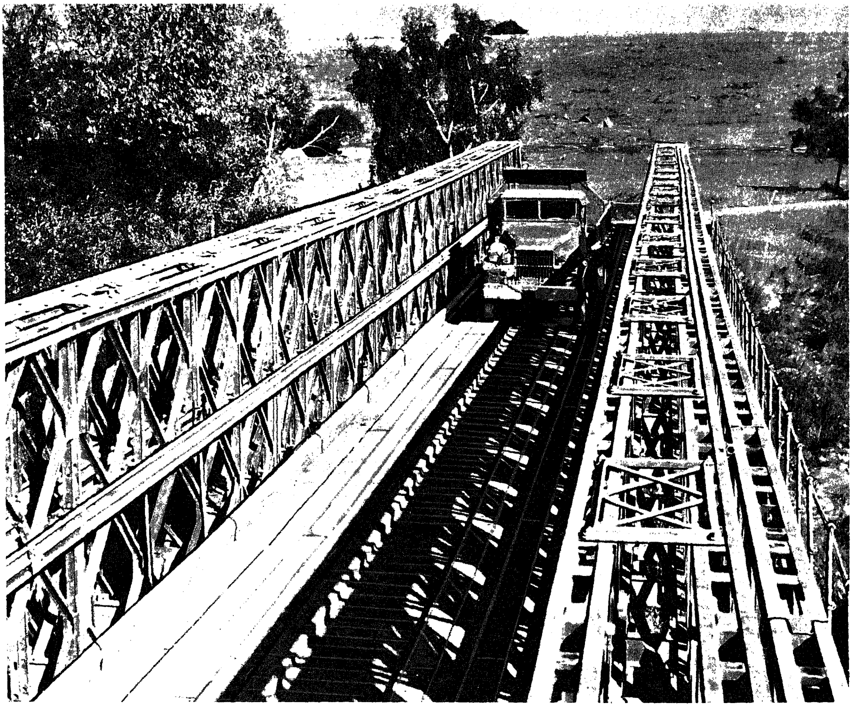


Figure 1–1. Truck crossing triple-double panel bridge.

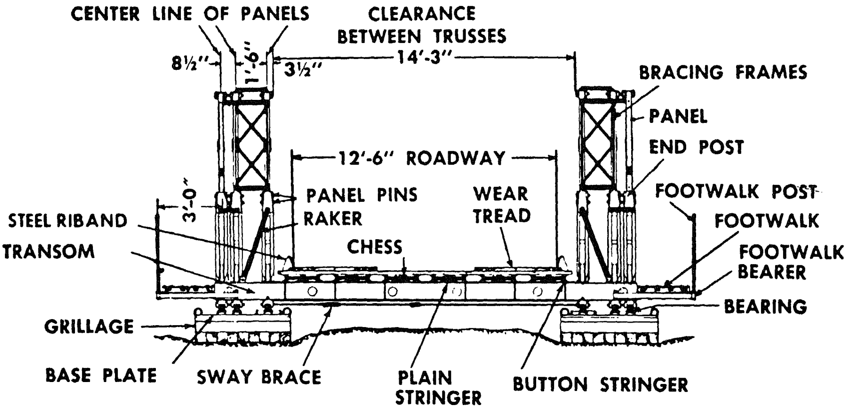


Figure 1–2. Panel bridge, Bailey type, M2.

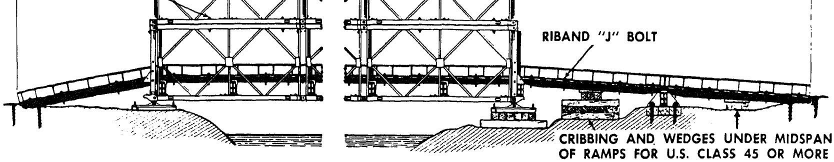


Figure 1–3. Elevation view, Bailey bridge.

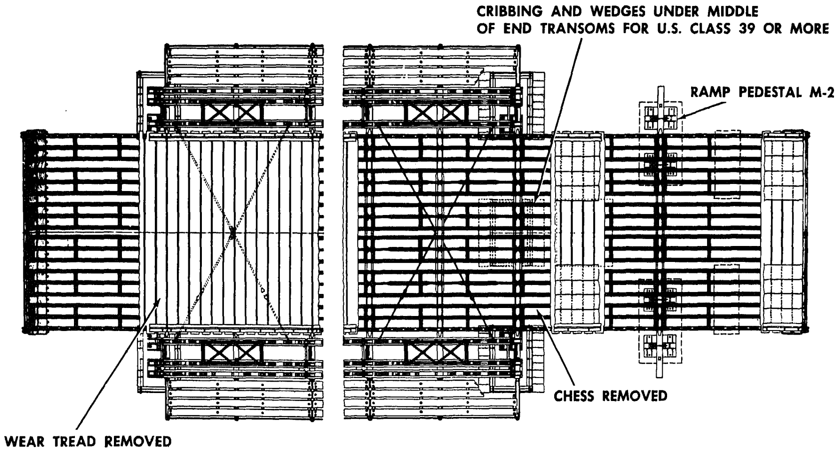


Figure 1–4. Plan view, Bailey bridge.

Type	*Usual nomenclature*	*Abbreviation*
Single-truss, single-story	Single-single	SS
Double-truss, single-story	Double-single	DS
Triple-truss, single-story	Triple-single	TS
Double-truss, double-story	Double-double	DD
Triple-truss, double-story	Triple-double	TD
Double-truss, triple-story	Double-triple	DT
Triple-truss, triple-story	Triple-triple	TT

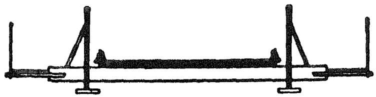
c. Materials. The decking, called chess, is wood. Panels, end posts, transoms, and ramps are a low-alloy, high tensile steel. All other parts are carbon structural steel. All joints in the parts are welded.

d. Deck. The clear roadway between curbs called ribands, is 12 feet 6 inches wide. The transoms supporting the roadway are normally set on the bottom chords of the bottom story. Ramps are used at each end of the bridge. The slope of the ramp must not exceed 10 to 1 for loads up to and including 50 tons, and 20 to 1 for loads over 50 tons. Footwalks can be carried on the transoms outside of the main trusses on each side of the bridge.

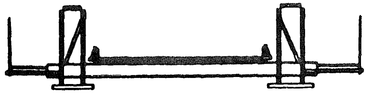
c. Bearings. End posts pinned to the end of each truss sit on cylindrical bearings, which rest on a steel base plate. On soft soil, timber grillages are used under the base plates to distribute the load. The bridge can be assembled between banks at different elevations, but the slope should not exceed 30 to 1.

1–5. Types of Structures

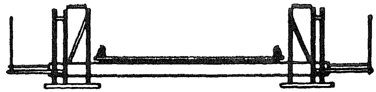
Panel bridge equipment can be used to assemble fixed bridges and panel crib piers and towers. Other special structures such as floating bridges,



SINGLE-TRUSS SINGLE-STORY
(SINGLE—SINGLE) (SS)

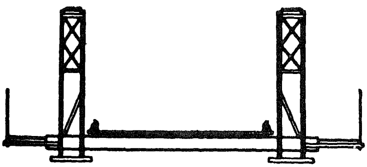


DOUBLE-TRUSS SINGLE-STORY
(DOUBLE—SINGLE) (DS)

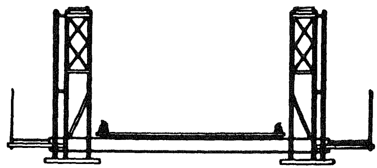


TRIPLE-TRUSS SINGLE-STORY
(TRIPLE—SINGLE) (TS)

Figure 1–5. Single-story bridges.



DOUBLE-TRUSS DOUBLE-STORY
(DOUBLE—DOUBLE) (DD)



TRIPLE-TRUSS DOUBLE-STORY
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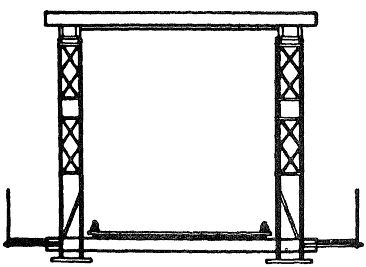
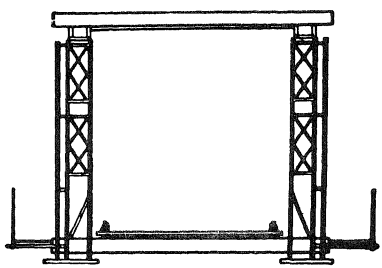
Figure 1–6. Double-story bridges



DOUBLE-TRUSS TRIPLE-STORY
(DOUBLE—TRIPLE) (DT)



TRIPLE-TRUSS TRIPLE-STORY
(TRIPLE—TRIPLE) (TT)

Figure 1–7. Triple-story bridges.

suspension bridges, retractable bridges, and mobile bridges, can be assembled using special parts.

a. Normal Assembly. Panel bridge equipment is normally used to assemble fixed simple-span through-type bridges from 30 to 210 feet long. The bridge can be assembled to meet varying conditions of span and load. Bridge weight per bay is given in table 1–1.

b. Special Assemblies.

(1) *Bridges.* Panel bridge equipment can also be used to assemble two-lane, through-type bridges, deck type bridges, railway bridges, bridges on piers, and floating bridges.

SS	2.76
DS	3.41
TS	4.01
DD	4.66
TD	5.88
DT [2]	6.46
TT [2]	8.29
Launching-nose bays	
SS	1.00
DS	1.64
DD	2.90
Decking	
Chess and steel ribands	0.66
Stringers only	0.79
Wear treads (four 8″ x 12″ planks on each side)	0.35
Miscellaneous	
Footwalks	0.17
Overhead bracing (supports, transoms, sway bracing, and chord bolts)	0.54

[1] Footwalks and wear treads not included.
[2] Oervhead bracing included.

(2) *Piers.* Panel crib piers and towers up to 70 feet high supporting continuous spans, and up to 110 feet high supporting broken spans, can be assembled with panel bridge equipment and special crib-pier parts.

(3) *Expedients.* Panel bridge equipment can also be used in whole or in part to build many structures, such as causeways, box anchors, towers for floating bridge cables, and loading hoppers and gantries.

United States adopted from the British their prefabricated Bailey bridge, US nomenclature M1. This bridge was redesigned to provide a greater roadway width of 12 feet 6 inches, and designated as the Panel Bridge, Bailey Type, M2. The British have widened the bridge once again and now have the M3, commonly called the extra widened Bailey Bridge, as standard.

b. Advantages. The Bailey bridge is versatile and can be assembled in many ways, such as a through-type bridge, both fixed and floating, and as a fixed deck-type bridge. Some of the characteristics which make the Bailey bridge valuable to field commanders are its ease of installation, mobility, and versatility.

(1) *Ease of installation.* Each part of a Bailey bridge is a standard machine-made piece and goes into the bridge the same way in each span. With the exception of triple-story assembly, no heavy equipment is normally required to assemble or launch a Bailey bridge. Only basic pioneer skills and equipment are needed.

(2) *Mobility.* All the parts of the bridge can be moved by 5-ton dump trucks and trailers.

(3) *Versatility.* Standard parts can be used to assemble seven standard truss designs for efficient single spans up to 210 feet in length, and to build panel crib piers supporting longer bridges. With minor nonstandard modifications, the expedient uses of its parts are limited only by the user's imagination.

CHAPTER 2

DESCRIPTION OF EQUIPMENT

Section I. BRIDGE PARTS

2-1. General

The bridge parts and erection equipment supplied in the panel bridge set are listed in table 2-1 and illustrated in figures 2-1 through 2-38. Table 2-1 shows the number of parts needed to build a specific Bailey bridge.

Table 2-1. Number of Parts Needed for Bailey Bridges

(Located in Back of Manual)

2-2. Panel

a. The panel (fig 2-1) is the basic member of the bridge. It is a welded high tensile steel truss section 10 feet long, 5 feet 1 inch high, and 6½ inches wide. It weighs 577 pounds and can be carried by six men using carrying bars.

b. The horizontal members of the panel are called chords. Transoms are clamped to four seatings on top of the bottom chord next to the panel verticals. Table 2-2 lists the holes in the panel chords and verticals.

Table 2-2. Holes in Panel Chords and Verticals

Position of hole	Type of bolt used in hole	Use of hole
Near each end of bottom chord.	Sway brace pin	Fasten ends of sway braces.
Top and bottom chords.	Bracing bolt	Fasten bracing frames between two inner trusses.
Top and bottom chords.	Chord bolt	Fasten chords of multi-story bridges.
End verticals	Bracing bolt	Fasten rakers. Fasten bracing frames between two inner trusses. Fasten tie plates between second and third trusses.
Bottom of all verticals.	Transom clamp	Fasten transom by insertion of transom clamp.

c. Both chords have male lugs at one end and female lugs at the other. Panels are joined end to end by engaging these lugs and placing panel pins through the holes in the lugs.

2-3. Panel Pin

The panel pin (fig 2-2) is 8-5/16 inches long, 1⅞ inches in diameter, and weighs 6 pounds. It has a tapered end with a small hole for a bridge pin retainer (safety pin). A groove is cut across the head of the panel pin parallel to the bridge pin retainer (safety pin) hole. Panel pins should be inserted with the groove horizontal; otherwise, the flanges of the panel chord channels make it difficult to insert the safety pin.

2-4. Short Panel Pin

The short panel pin (fig 2-3) is ¾ inch shorter than the normal panel pin and weighs 5.8 pounds. It is used to pin the end posts of the outer and middle trusses in a triple-truss bridge.

2-5. Transom

Note: This manual, in referring to beams making up some components of the bridge, uses the designations WF-beam and I-beam. The new Manual of Steel Construction of the American Institute of Steel Construction designates the WF-beams as W-Shape beams, and the I-beams as I-Shape beams. Both designations are likely to be encountered during a transition periods.

a. The transom (fig 2-4) supports the floor system of the bridge. It is a 10-inch WF-beam, 19 feet 11 inches long, with a 4½-inch flange and a 5/16-inch cover plate on each flange. It weighs 618 pounds and is carried by eight men using carrying tongs clamped to the upper flange or carrying bars inserted through holes in the web.

b. The under side of the transom has six holes into which the panel dowels fit. The upper side of

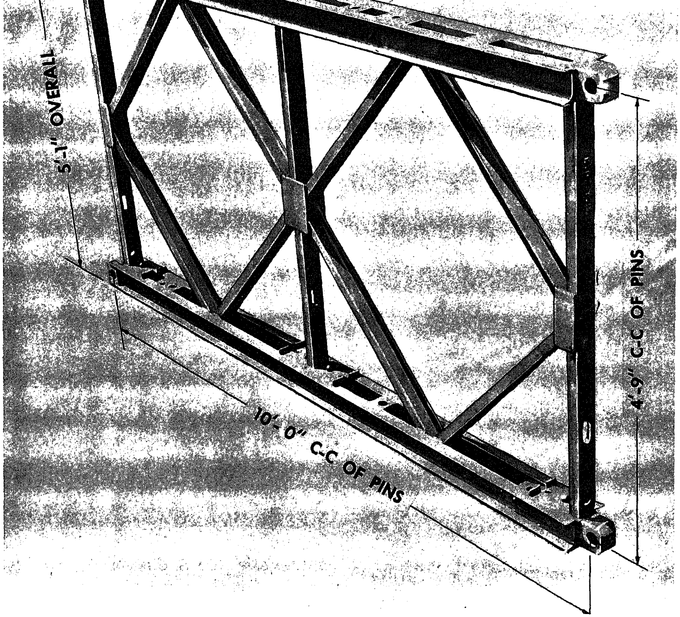


Figure 2–1. Panel.

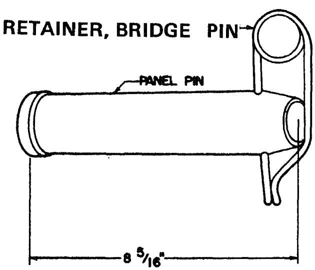


Figure 2–2. Panel pin.

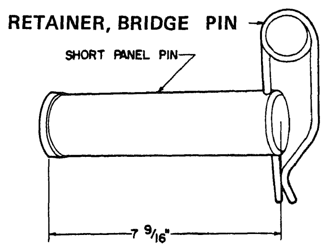


Figure 2–3. Short panel pin.

the transom has six lugs which position the stringers, and an additional lug near each end to which the raker, or side strut, is bolted. Lugs for the footwalk bearer are near each end on the web and flange of the WF-beam.

c. The transoms rest on the lower chords of the panels and are held in place by transom clamps. Transoms are normally spaced 5 feet apart, one at the middle and one at one end of each panel to support vehicles of class 70 or less. Four transoms per bay are required to support vehicles over class 70. The bridge must never be jacked up under transoms because the transom clamps will fail.

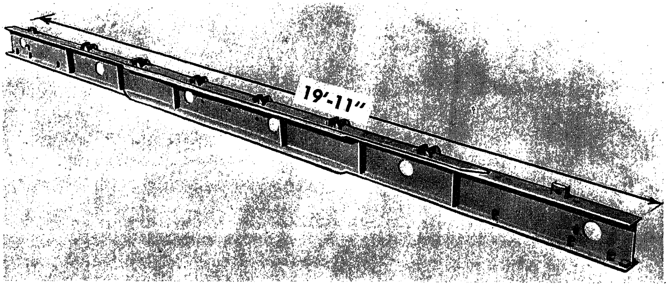


Figure 2-4. Transom.

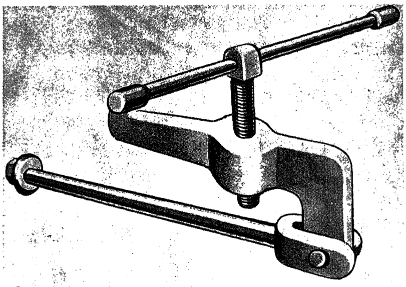


Figure 2-5. Transom clamp.

When necessary, jacks may be placed under transoms held by end-post holddown brackets provided that the jacks are placed as close as possible to the truss panels.

2-6. Transom Clamp

The transom clamp (fig 2-5) is a hinged screw type clamp, 13½ inches high and 8 inches across the top. It weighs 7 pounds. It clamps the transom to the vertical and bottom chord of the panel. It is tightened by a vise-handled screw.

2-7. Raker

The raker (fig 2-6) is a 3-inch I-beam with a 2⅜-inch flange. It is 3 feet 8-5/16 inches long and weighs 22 pounds. A raker connects the end of the transom to the top of the panels of the inner truss and prevents the panels from overturning. At each end of the raker is a hollow dowel for the bracing bolts; it fits through a hole in the panel and a hole in the transom.

2-8. Bracing Frame

The bracing frame (fig 2-7) is a rectangular frame, 4 feet 3 inches by 1 foot 8 inches, with a hollow conical dowel in each corner. It weighs 44 pounds. The bracing frame is used to brace the inner two trusses on each side of the double- and triple-truss bridge. Bracing bolts attach the bracing frames horizontally to the top chords of the bridge and vertically on one end of each panel in the second and third stories.

2-9. Sway Brace

The sway brace (fig 2-8) is a 1⅛-inch steel rod, hinged at the center, and adjusted by a turnbuckle. It weighs 68 pounds. At each end is an eye, through which a pin on a chain is inserted to secure it to the panel. The sway brace is given the proper tension by inserting the tail of an erection wrench in the turnbuckle and screwing it tight. The locknut is then screwed up against the turnbuckle. Two sway braces are required in the lower chord of each bay of the bridge and all except the first bay of the launching nose, and in each bay of overhead bracing.

2-10. Tie Plate

A tie plate (fig 2-9) is a piece of flat steel 2½ by ⅜ by 12 inches weighing 3½ pounds. It has a hollow conical dowel at each end. The tie plate is used only in triple-truss bridges; it secures the second truss to the third truss, using the unoccupied raker holes in the panels at each joint and at the ends of the bridge.

2-11. Bracing Bolt

A bracing bolt (fig 2-10) is ¾ inch in diameter, 3½ inches long, and weighs about 1 pound. A special lug on its head prevents rotation when the bolt is tightened. A 1⅛-inch wrench is used to tighten it. It is used to attach rakers to transoms and panels, attach bracing frames to panels, and attach tie plates to panels. It is inserted into the

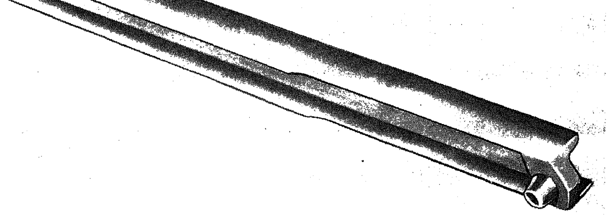


Figure 2–6. Raker.

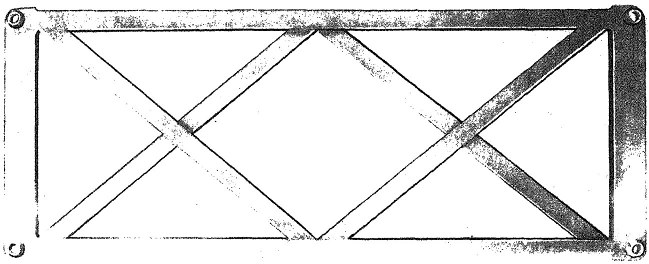


Figure 2–7. Bracing frame.

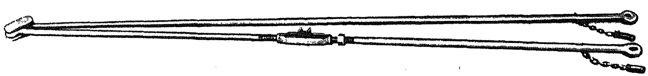


Figure 2–8. Sway brace.

Figure 2–9. Tie plate.

hollow dowels of the braces to draw parts into proper alinement.

2–12. Chord Bolt

A chord bolt (fig 2–11) is 1¾ inches in diameter, 10½ inches long, and weighs 7½ pounds. It is tapered through half its length to assist in drawing the panels into alinement. A 1⅞-inch wrench is used to tighten it. Chord bolts join the panels one above the other to form double- and triple-story bridges. Two bolts per panel pass upward through holes in the chords of the panels and are tightened with nuts on the lower chord of the

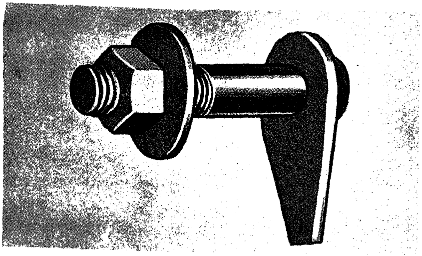


Figure 2–10. Bracing bolt.

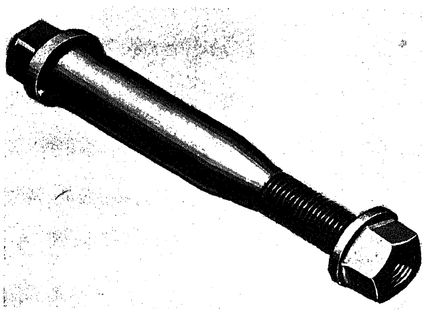


Figure 2–11. Chord bolt.

upper story. They are also used to fasten overhead bracing supports to the top panel chord.

2–13. Stringers

Stringers (fig 2–12) carry the roadway of the bridge. Each stringer consists of three 4-inch steel I-beams, 10 feet long, joined by welded braces. There are two types of stringers: plain stringers weighing 260 pounds, and button stringers weighing 267 pounds. They are identical except that the latter has 12 buttons which hold the ends of the chess in place. Each bay of the bridge has six stringers: four plain stringers in the middle, and a button stringer on each side. The stringers are positioned by the lugs on the top of the transoms.

2–14. Chess

Chess (fig 2–13) form the road surface. A chess is 2 inches by 8¾ inches by 13 feet 10 inches. It is made of wood and weighs 65 pounds. It is notched at the ends to fit between the buttons of the bottom stringer. Each bay of the bridge contains 13 chess, which lie across the stringers and are held in place by the buttons on the stringers. Chess are held down by ribands.

2–15. Steel Riband (Curbs)

A riband (fig 2–14) is a metal curb 8 inches high and 10 feet long. It weighs 162 pounds. It is fastened to the button stringers by four J-type riband bolts.

2–16. Riband Bolt

A riband bolt (fig 2–15) is a J-type bolt 1 inch in

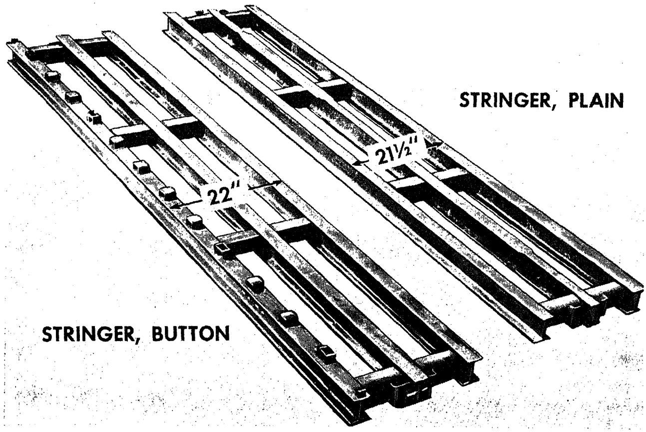


Figure 2–12. Stringers.

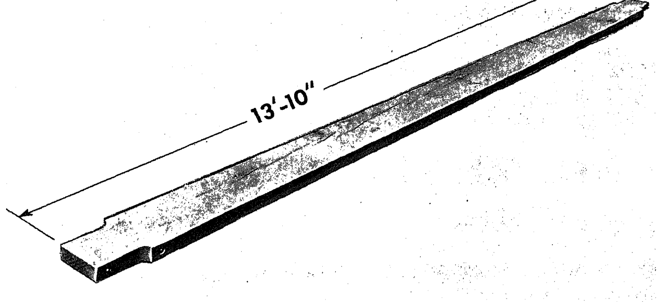


Figure 2–13. Chess.

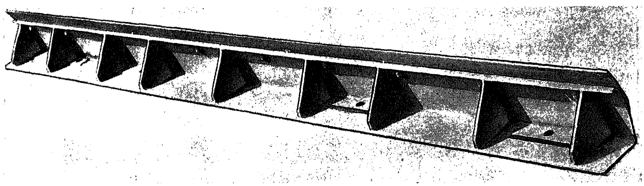


Figure 2–14. Riband.

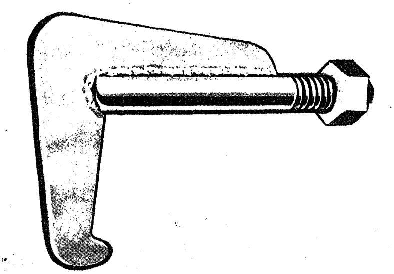


Figure 2–15. Biband bolt.

diameter and $8\frac{5}{8}$ inches long. It weighs $4\frac{1}{2}$ pounds. A $1\frac{1}{2}$-inch wrench is used to tighten it. The riband bolt fastens the riband to the button stringers and ramps. The hook end of the bolt grips the lower flange of the outer I-beam of the button stringer or ramp.

2–17. End Posts

End posts (fig 2–16) are used on both ends of each truss of the bridge to take the vertical shear. They are placed only on the story carrying the decking. They are 5 foot 8 inch columns made of two 4-inch channels and plates welded together. There are two types, male and female, having male and female lugs, respectively. These lugs are secured to the end panels of the bridge by panel pins through holes in the lugs. The male and female end posts weigh 121 and 130 pounds, respectively. End posts have a step to support a transom outside the panel at one end of the bridge. In jacking the bridge, the jack is placed under the step. The lower end of the end post has a half-round block which fits over the bearing.

2–18. Bearing

The bearing (fig 2–17) spreads the load of the bridge to the base plate. A bearing is a welded steel assembly containing a round bar which, when the bridge is completed, supports the bearing blocks of the end posts. During assembly of the bridge, it supports the bearing block of the rocking roller. The bar is divided into three parts

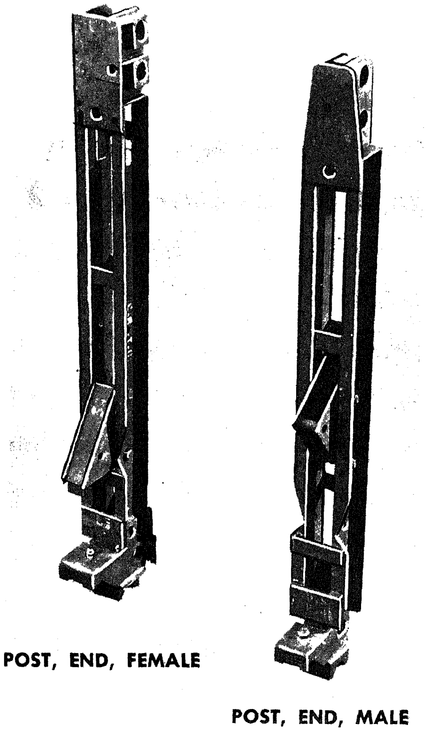


Figure 2–16. End posts.

by two intermediate sections that act as stiffeners. The bearing is 4-5/16 inches high and weighs 68 pounds.

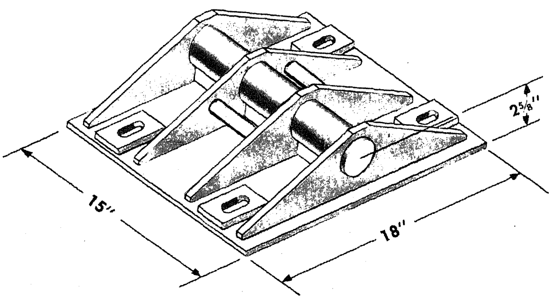
2–19. Base Plate

The base plate (fig 2–18) is a welded steel assembly with built-up sides and lifting-hook eyes on the top at each corner. It is used under the bearings to spread the load from the bearings over the ground or grillage. The area of the bottom surface of the base plate is 13½ square feet. The base plate weighs 381 pounds and is large enough for the bearings at one corner of a single-, double-, or triple-truss bridge. Bearings can slide 9 inches longitudinally on the base plate. The numbers 1, 2, and 3 are embossed on the edges of the base plate to indicate the position of the plate under the inner truss of single-, double-, and triple-truss bridges respectively.

2–20. Ramps

a. Ramps (fig 2–19) are similar to stringers, but consist of three 5-inch, instead of 4-inch, steel I-beams. They are 10 feet long and are joined by welded braces. The lower surface of the ramp tapers upward near the ends. There are two types of ramps: plain ramps weighing 338 pounds, and button ramps weighing 349 pounds. They are identical except that the latter have 12 buttons which hold the ends of the chess in place.

b. Four plain and two button ramps are used as continuations of the stringers and lead from the bridge to the banks. If the slope is too steep, double-length ramps are used, supported at the joint by a transom held in place by four ramp pedes-



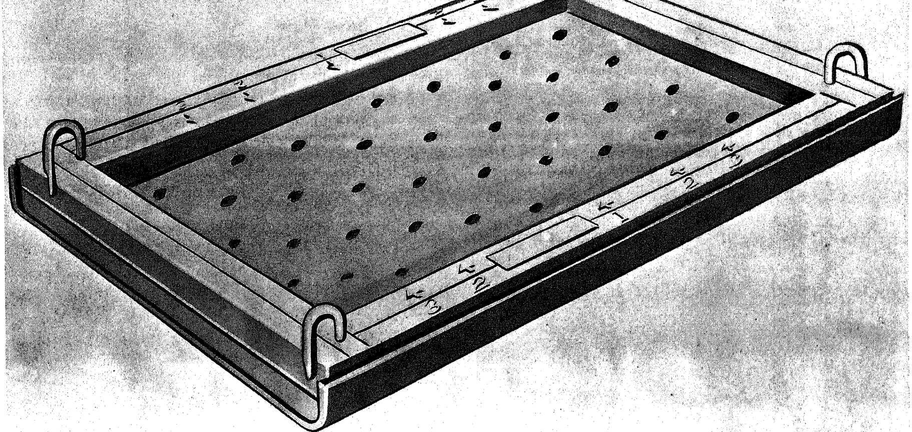


Figure 2-18. Base plate.

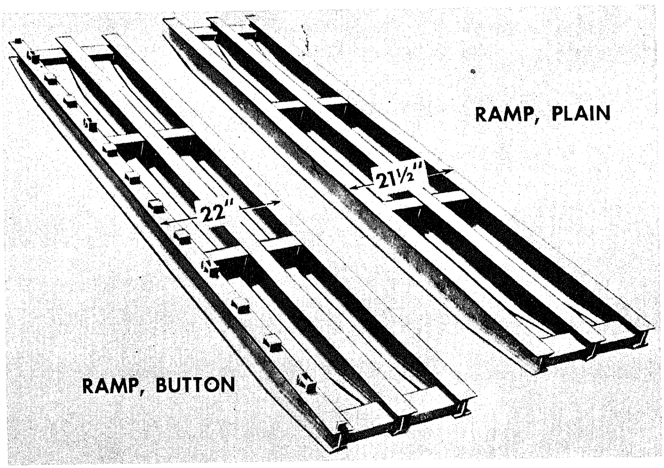


Figure 2-19. Ramps.

tals. For loads of 45 tons or over, the ramps are supported at their midpoints by timber cribbing and wedges. The ends of the ramps fit into lugs on the transoms at the ends of the bridge.

2-21. Ramp Pedestal

Ramp pedestals (fig 2-20) are built-up welded steel assemblies weighing 93 pounds. They prevent the transoms supporting multiple-length

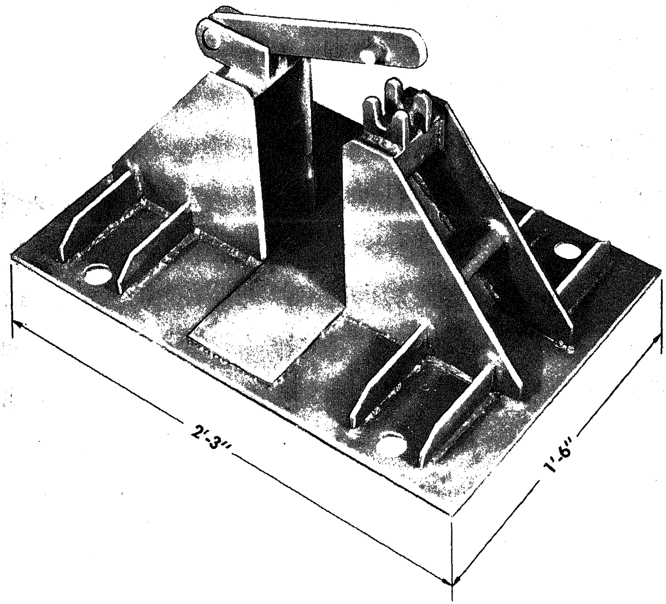


Figure 2–20. Ramp pedestal.

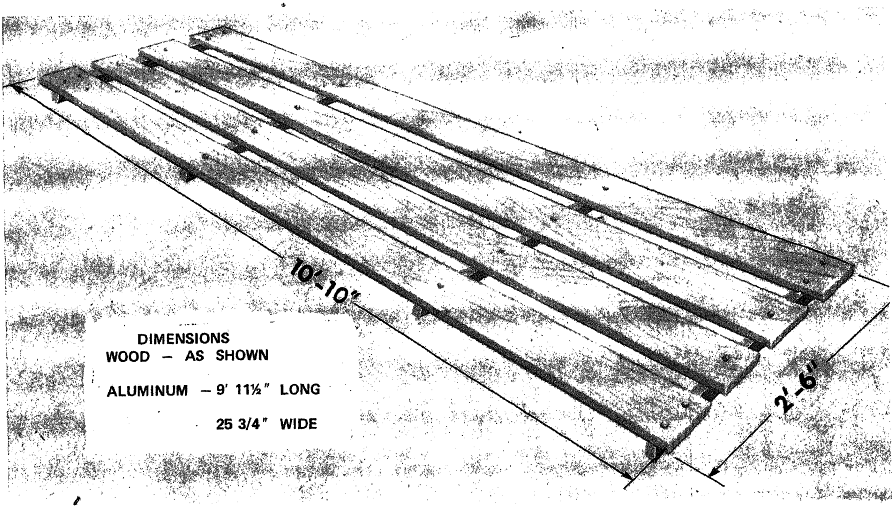


Figure 2–21. Footwalk.

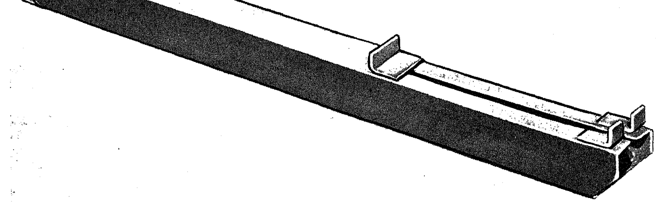


Figure 2–22. Footwalk bearer.

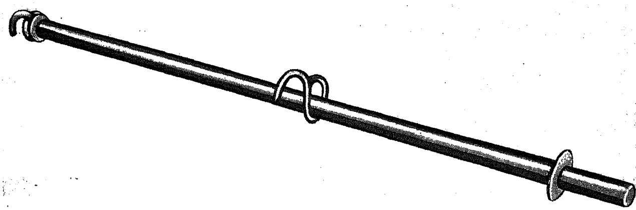


Figure 2–23. Footwalk post.

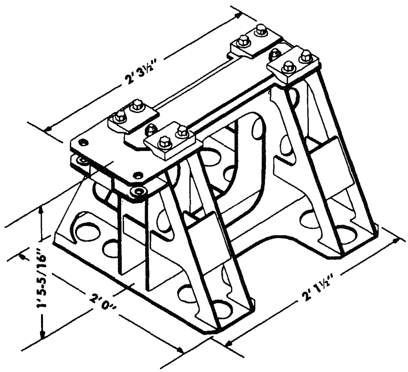


Figure 2–24. Overhead bracing support.

ramps from overturning and spread the transom load over the ground. They are held in place by spikes or pickets driven through holes in their base plates.

2–22. Footwalk

The footwalk (fig 2–21) may be of wood or aluminum. The older type, made of wood, may still be in use. Current footwalks are of aluminum. The wood walks are 2 feet 6 inches wide and 10 feet 10 inches long and the aluminum footwalks are 25¾ inches wide and 9 feet 11½ inches long. Supported on footwalk bearers, footwalks are laid along the outer sides of the bridge for use by foot troops.

2–23. Footwalk Bearer

A footwalk bearer (fig 2–22) is a built-up beam of pressed steel 4 feet long, weighing 23 pounds. Bearers are attached to all transoms except reinforcing transoms, fitting over and under special lugs welded to the web near the ends of the transom. The footwalk fits between lugs on top of the bearers. A socket at the end of the bearer holds the footwalk post.

2–24. Footwalk Post

A footwalk post (fig 2–23) 4 feet high and weighing 10 pounds is fitted into every footwalk bearer. Hand ropes are threaded through two eyes on each post and secured either to holdfasts on the banks or to the end footwalk posts.

2–25. Overhead Bracing Support

The overhead bracing support (fig 2–24) is used to clamp overhead transoms and sway braces to trusses for overhead bracing of triple-story bridges. The frame is a welded metal assembly that weighs 150 pounds. It is fastened to the tops of third story panels by chord bolts. A transom is seated over the pintles on top of the frame and secured by cleats over the lower flange held by four nuts and bolts.

Section II. ERECTION EQUIPMENT

2–26. Rocking Roller

a. The rocking roller (fig 2–25), weighing 206 pounds, consists of three rollers housed in a balanced arm which fits over the bearing and is free to rock on it. Two side rollers on the flange on each side of the rocking roller frame act as guides for the trusses. The side rollers can be removed from the flanges by removing split pins from spindles underneath the flange; they then remain loosely attached to the frame by a chain.

b. The rollers distribute the bridge load along the bottom chord during launching. One pair of rollers is required for single-truss bridges, and two pairs for double-truss and triple-truss bridges. On triple-truss bridges, the rollers are placed only under the inner and second trusses and the outer side rollers of the rocking rollers are removed. One pair of rocking rollers is normally required on the far bank; two pairs are used if the skeleton launching nose is double-truss in any part. The maximum allowable load on one rocking roller is 30 tons.

2–27. Plain Roller

a. The plain roller (fig 2–26) is 2 feet 1½ inches wide and consists of a welded housing containing a single roller split in two. The plain roller weighs 116 pounds. The maximum allowable load on one roller is 10 tons.

b. During launching, plain rollers are placed every 25 feet behind the rocking rollers and at other required places, except at the bank seats. Trusses of single-truss bridges can be carried on either half of the roller. Second and third trusses of triple-truss bridges are carried on both halves.

2–28. Transom Roller

The transom roller (fig 2–27) is a roller having an outside diameter of approximately 1⅞ inches (1½ inch extra heavy steel pipe) and a length of 6⅝ inches. The roller is fitted with bronze bushings at each end and revolves on a 1-inch diameter steel pin mounted in a steel frame which is built up from standard steel bars and angles. The roller assembly is 8 inches long, 7⅝ inches wide, and 5¾ inches high overall. It weighs approximately 12 pounds. The roller is used to simplify and expedite the work of placing and removing transoms during the assembly and disassembly of the bridge.

2–29. Jack

a. The jack (fig. 2–28) used to lift the bridge on and off the rocking rollers is a mechanical lifting

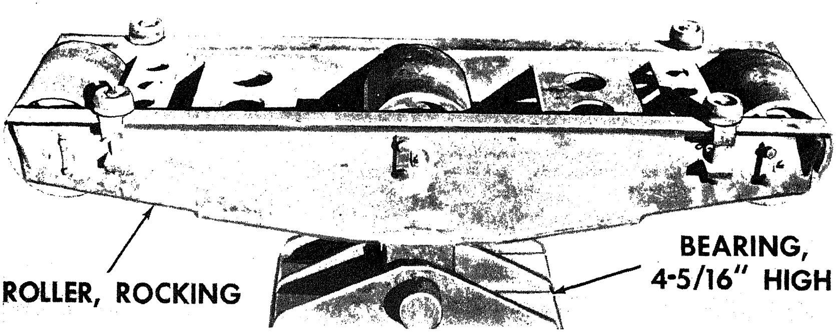


Figure 2–25. Rocking roller.

When the weight is carried on its toe, its capacity is only 7½ tons. It weighs 128 pounds.

b. Jacks of different manufacture have different spacing (pitch) between teeth as listed in table 2–3. Where jacks are lifting at the same point, all jacks used must have the same tooth pitch so they can be operated in unison.

Table 2–3. Pitch of Teeth in Panel Bridge Jacks

Manufacturer	Model No.	Distance between teeth (pitch in inches)
Joyce	1928	7/16
Simplex	29	15/32
Buda	2815	5/16
Duff-Norton	2815	5/16

2–30. Jack Shoe

The jack shoe (fig 2–29) is a welded assembly which fits over the bearing and supports the jack.

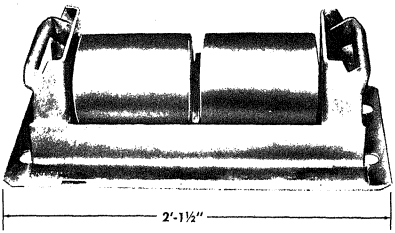


Figure 2–26. Plain roller.

and weighs 36 pounds. It fits over the bearing on the base plate.

2–31. Wrenches

The wrenches (fig 2–30) provided in the bridge set are listed in table 2–4.

Table 2–4. Wrenches Provided With Panel Bridge Set

Wrench	Use
1⅛ inch offset socket wrench	Tighten bracing bolts.
1⅛ inch offset structural wrench.	Tighten bracing bolts. Tighten riband bolts.
1½ inch offset structural wrench.	Tighten sway braces (use tail of wrench).
1⅞ inch offset structural wrench.	Tighten chord bolts.
Reversible ratchet-wrench handle with 1⅛ inch and 1⅞ inch sockets.	Tighten bracing bolts (use 1⅛ inch socket). Tighten chord bolts (use 1⅞ inch socket).

2–32. Panel Lever

The panel lever (fig 2–31) used in assembling the second and third trusses after the first truss is in place over the gap, is a wooden bar 7 feet 9 inches long weighing 48 pounds. It has a fulcrum near the center and a lifting link at the end. The lifting link has a swiveling crosspiece which can be readily attached to the top of a panel by passing it through the upper chord and turning it. The upper end of the link slides in a slot—the inner end of the slot is used when erecting the second truss and the outer end when erecting the third

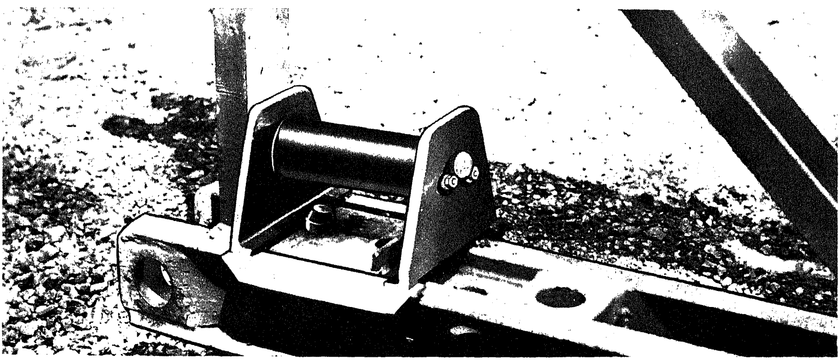


Figure 2–27. Transom roller in position.

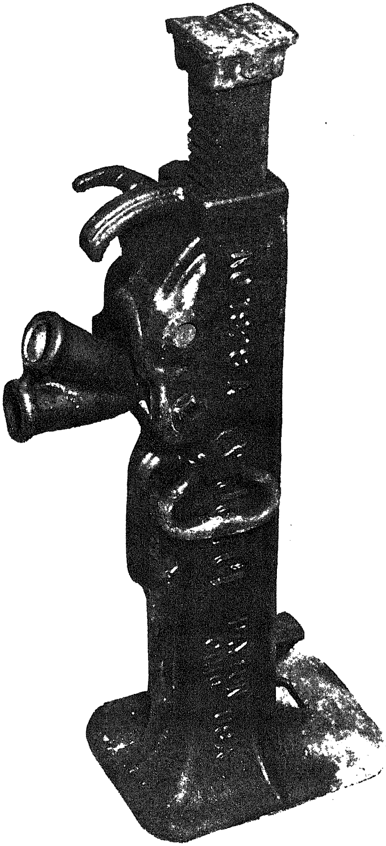


Figure 2–28. Jack.

truss. The fulcrum is always placed on the top of the first truss. Two levers per panel are required, with two men operating each lever.

?–33. Carrying Bar

\ wooden carrying bar (fig 2–32) 3 feet 6 inches ong, reinforced by a steel band at the middle, is used to carry panels and transoms. It weighs 8 pounds.

2–34. Carrying Tongs

Carrying tongs are steel and are shaped like rail-

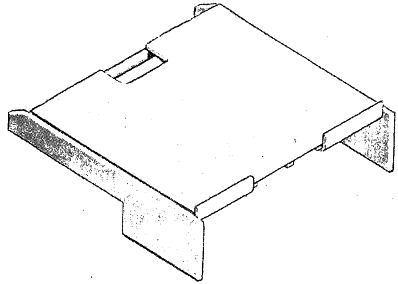


Figure 2–29. Jack shoe.

road tongs as shown in figure 2–33. These tongs are used to carry transoms by clamping them over the top flange. One man carries each of the two handles of the tongs. Normally four pairs of tongs and eight men are used to carry a transom.

2–35. Chord Jack

a. The chord jack (fig 2–34) consists of two welded steel frames which fit on the top chord and engage with the plates which carry the holes for bracing-frame dowels. Each frame is held down by a bolt through the chord and the frame. A knuckle-threaded screw assembly fits between the frames and is operated by a ratchet lever to force them apart. The lever has a shackle at its end to which a rope can be attached to facilitate operation.

b. When adding a second or third story to a bridge already launched, work should start in the middle and proceed towards the ends. Upper jaws of the second-story panels will be over-engaged because of the natural sag of the bridge. The chord jack is used to spread the jaws and allow the upper panel pins to be inserted. For detailed description of the use of the chord jack, see paragraph 8–14.

2–36. Pin Extractor

The pin extractor (fig 2–35) assists in dismantling the bridge. After the pin has been driven part way out and the recess under the head of the pin is exposed, the pin extractor grips the pin head and forces the pin out by a levering action. It is particularly useful for dismantling the third truss of a triple-truss bridge, because the closeness of the second truss makes it impossible to drive the pins out with a hammer.

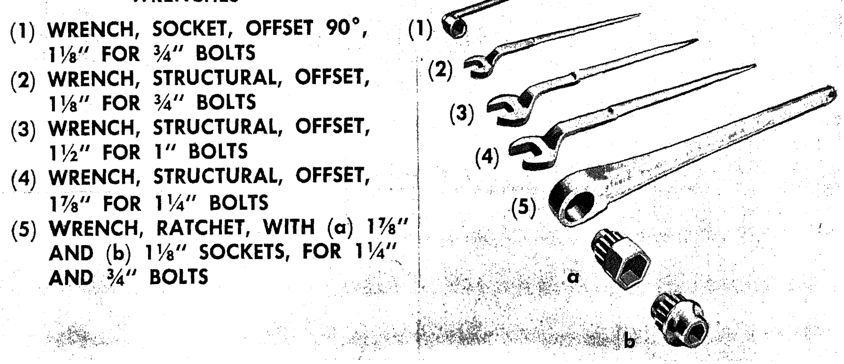


Figure 2–30. Wrenches.

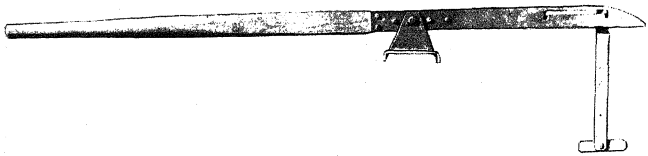


Figure 2–31. Panel lever.

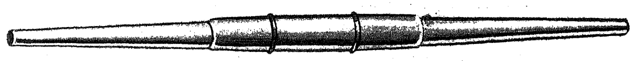


Figure 2–32. Carrying bar.

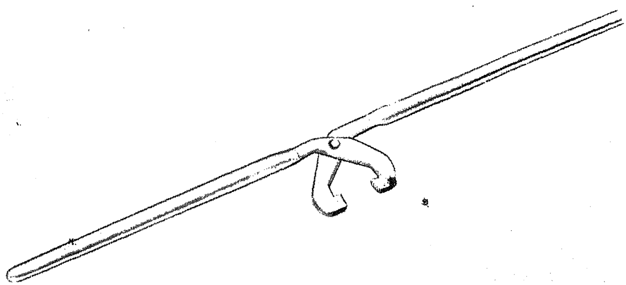


Figure 2–33. Carrying tongs.

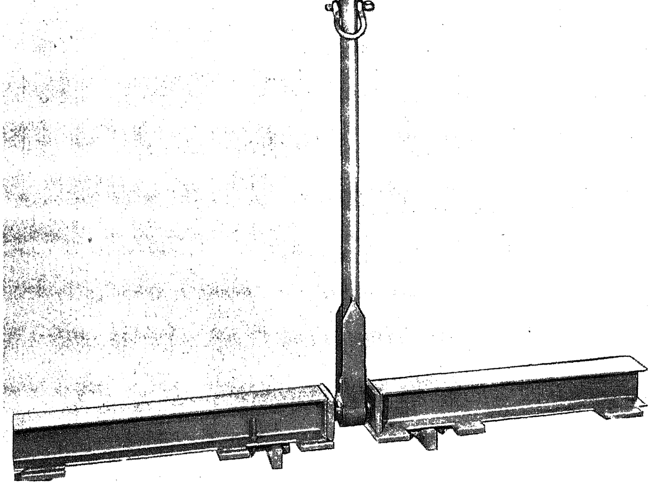


Figure 2–34. Chord jack.

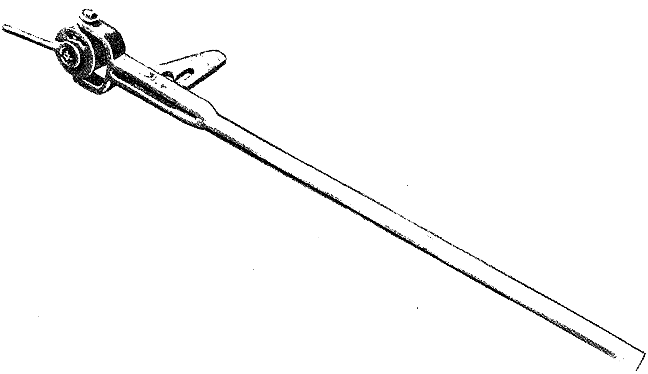


Figure 2–35. Pin extractor.

2–37. Launching-Nose Link MK II

a. The launching-nose link MK II (fig 2–36) is about 10 inches long and 7 inches wide and weighs 28 pounds. Links consist of two steel frames welded back to back. The lugs of two panels fit into the links. The sides of the links have holes into which panel pins can be inserted. The links lie flush with the underside of the bottom chords of the panels and have a false flange welded on the bottom edge so the bridge can be rolled out on launching rollers. The link has a pintle on the top to seat a transom.

b. The launching-nose links overcome the sag occurring when the launching nose is cantilevered over the gap. Using one link on each truss increases the length of the bottom chords of the launching nose by 7½ inches, thus raising the end of the launching nose by 13½ inches for each bay ahead of the links. The links must not be inserted with more than four bays of the launching nose

required, an additional pair of links can be used in one of the joints between the original pair and the end of the nose, its position depending on how much lift is required. The maximum lift obtainable is approximately 94½ inches.

c. The launching-nose links are also used between the upper jaws of span junction posts dur-

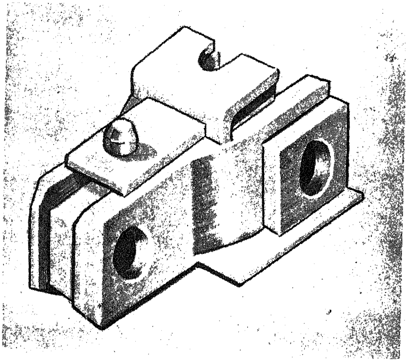


Figure 2–36. Launching-nose link MK II.

2–38. Templates

Two types of templates are provided, one to locate the bearings for the rocking rollers and the other for the plain rollers.

a. Rocking-Roller Template. The rocking-roller template (fig 2–37) weighs 78 pounds and consists of a timber base with timber strips on top which surround two spaces large enough for rocking-roller bearings. At one end of the template are two angle cleats which are used as measuring points. One template is placed on each side of the bridge with 11 feet 6½ inches between cleats.

b. Plain-Roller Template. The plain-roller template (fig 2–38) weighs 22 pounds and consists of a timber base with timber strips on three sides and a steel strip on the fourth side surrounding a space large enough for the base of a single plain roller. It also has two angle cleats at one end for measuring points. When two rollers are used, one under each side of the bridge, the templates are 11 feet 6½ inches apart. When four rollers are used, two under each side of the bridge, two templates are used back to back under each pair and the pairs of templates are 10 feet 10½ inches apart.

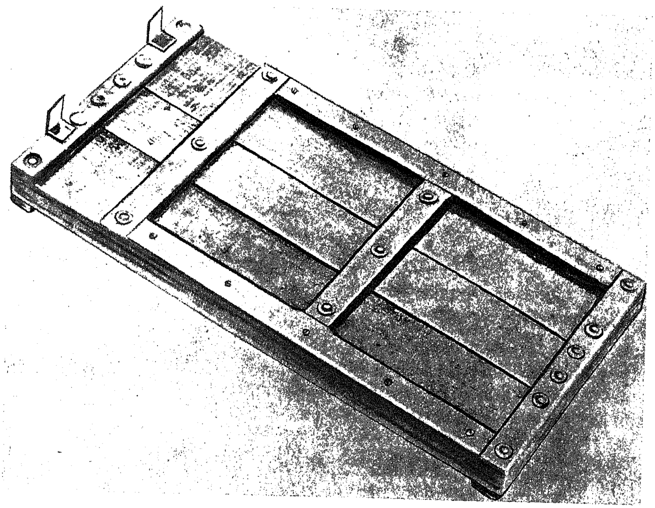


Figure 2–37. Rocking-roller template.

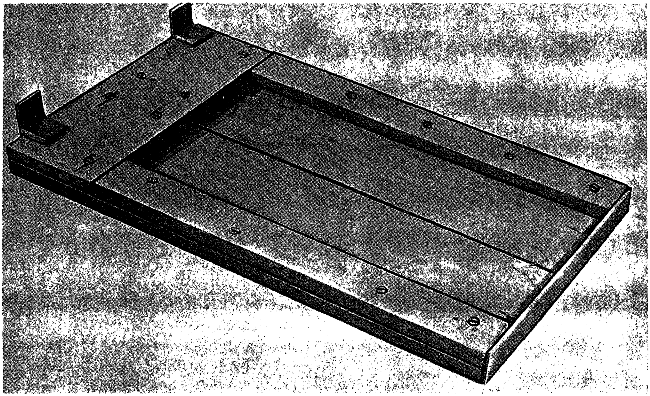


Figure 2–38. Plain-roller template.

CHAPTER 3

BRIDGING LOADS

3–1. Sets

a. Basic Bridge Set. Basic M2 bridge sets are stocked at depots. Parts for standard truck loads are drawn from these basic sets. Tables 3–1 and 3–2 list components of the M2 panel bridge basic set. The set contains enough parts and equipment to install two 80-foot double-single M2 bridges (with launching nose) or one 130-foot double-double bridge with launching nose.

Table 3–1. Bridge, Fixed, Steel Panel, Bailey Type M2—Components

Nomenclature	Average Unit Weight (lb)	Set Quantity	Total Weight (lb)
Bearer, footwalk	23	80	1,840
Bolt, Endpost, spares	0.75	24	18
Riband, guardrail "J"	4.5	440	1,980 (wood)
	4.5	400	1,800 (aluminum)
Bolt, bracing, bridge	1	1,200	1,200
Bolt, connector, chord	7.5	400	3,000
Brace, sway	68	64	4,352
Chess, M2	65	336	21,840
Clamp, transom	7	600	4,200
Footwalk, aluminum assembly		40	
Footwalk, wood	104	32	3,328
Frame, bracing, bridge	44	64	2,816
Nut, plain, hexagon		24	
Panel, truss, bridge	577	130	75,010
Pedestal, ramp	93	16	1,488
Picket, steel	12	40	480
Pin, connector, panel, 8 5/16" long	6.1	400	2,400
Pin, connector, panel, 7 9/16" long	5.8	38	220
Pin, sway brace	1.1	50	55
Plate, base, bearing	381	8	3,048
Plate, tie	3.5	42	147
Post, end, female	130	16	2,080
Post, end, male	121	16	1,936
Post, footwalk	10	80	800
Rake, side, strut	22	64	1,048
Ramp, button	348	16	5,568
Ramp, plain	338	32	10,816
Retainer, bridge pin	0.13	1,000	130
Riband, guardrail	162	48	7,776
Rope, manila 2" x 600'	7.5 '/lb	1	80
Screw, cap, hexagon, 4½"		24	
Shoe, bearing 4 5/16"	68	16	1,088
Stringer, button	267	36	9,612
Stringer, plain	260	72	18,720
Tape, luminous, 1" x 50 yds		2	
Transom, trestle	618	56	34,608
Total			233,400

Table 3–2. Bridge, Fixed, Steel Panel, Bailey Type M2—Erection Equipment

Nomenclature	Average unit weight (lb)	Set quantity	Total weight (lb)
Bag, Bailey bridge parts and tools	2	50	100
Bar, carrying	8	40	320
Block, double, for ¾" rope	8	8	64
Block, triple, for 1" rope	20	4	80
Block, snatch, for ¾" rope	6.3	4	25
Extractor, pin	18	4	72
Hammer, rubber-faced	4	45	180
Holdfast, complete w/9 pickets	160	12	1,920
Jack, ratchet-lever, 15 ton.*	128	10	1,280
Jack, chord	82	12	984
Lever, panel	48	12	672
Link, launching nose MK II	28	24	692
Lumber, softwood, dimension 3" x 6" x 4'6"	18	48	864
Lumber, softwood, dimension 6" x 6" x 4'6"	52	144	7,488
Nail, wire, steel		300	300
Roller, plain	116	12	1,392
Roller, rocking	206	12	2,472
Roller, transom, Bailey Bridge	12	4	48
Rope, sisal, lashing ⅝" x 25'	3.3	88	290
Rope, sisal, ¾" x 600"	102	2	204
Rope, sisal, 1" x 600"	156	2	312
Shackle, anchor type	5	4	20
Shoe, jack, 4 3/16" high	36	8	288
Sledge, blacksmith 8 lb	8	12	96
Spike ⅜" x 8"		20	20
Template, rocking roller	78	8	624
Template, roller, plain	22	12	264
Tongs, carrying, bridge erection	13	20	260
Wedge, wood	12	16	192
Wire rope assembly, single leg	12	4	48
Wrench, ratchet, reversible, with 1⅛" and 1⅞" sockets, for ¾" and 1¼" bolts	13	30	390
Wrench, socket, offset 90 degrees, 1⅛" for ¾" bolts	12	40	480
Wrench, structural, 1⅛" for ¾" bolts	2	60	120
Wrench, structural, 1½" for 1" bolts	4.7	30	141

Table 3-2. Bridge, Fixed, Steel Panel, Bailey Type M2—Erection Equipment—Continued

Nomenclature	Average unit weight (lb)	Set quantity	Total weight (lb)
Wrench, structural, 1 7/8" for 1 1/4" bolts	5.6	40	224
Total			22,926

*All jacks in one set must have same tooth pitch.

b. Conversion Set No. 3, Panel Crib Pier, M2. Conversion set No. 3 is used with equipment from the basic set to build panel crib piers. Table 3-3 lists component parts of conversion set No. 3. Enough parts are issued with each of these sets to provide the assembly of a triple-truss pier supporting two triple-truss broken spans and containing both horizontal and vertical stories.

*Table 3-3. Bridge Conversion Set No. 3, Bailey Type, Panel Crib Pier, Fixed M2**

Nomenclature	Average unit weight (lb)	Set quantity	Total weight (lb)
Bag, transport	2	30	60
Bearing, crib	37	24	888
Bearing, junction-link	217	6	1,302
Bolt, bracing	1	36	36
Bolt, chord	7.5	8	60
Brace, sway, M2	68	12	816
Capsill, crib	251	12	3,012
Chess, junction, M2	149	4	596
Clamp, chord	11	32	352
Clamp, transom	7	32	224
Frame, bracing	44	4	176
Link, junction	36	6	216
Link, launching-nose, Mk II	28	6	168
Pin, panel	6.1	120	732
Pin, safety	.13	200	26
Pin, sway-brace (spare)	1.1	2	2
Plate, tie	3.5	16	56
Post, junction, span, female	202	6	1,212
Post, junction, span, male	194	6	1,164
Raker	22	16	352
Total			11,450

*One bridge conversion set No. 3 makes two crib-pier loads.

3-2. Recommended Bridging Loads

a. Transport. The engineer company (panel bridge) normally transports one set of Bailey bridges on 5-ton dump trucks and 2½-ton pole-type utility trailers. The company has two platoons, each capable of transporting one 80-foot bridge (the most common bridge installed).

b. Bridging Loads. The loads shown in figures 3-1 through 3-9 have the following features:

(1) All loads are within the rated capacity of the assigned vehicles.

(2) The loading lends itself to stockpiling or assembly on a restricted site. A launching nose can be started with only three loads on the site.

(3) The number of trailers is 40 percent of the number of trucks. This fact makes it possible to use trucks to tow inoperative vehicles if necessary.

(4) Erection equipment is spread over four trucks and one trailer, thereby minimizing the effect of loss or breakdown.

(5) Trucks are loaded with all the female or all the male panel ends toward the rear of the vehicles.

(6) Steel cables are used for tiedowns on all truckloads.

c. Load Listing. The loads are listed below:

Truck load No. 1(5-ton truck—Parts and grillage load (fig 3-1 and table 3-4).

Truck load no. 2 (5-ton truck)—Launching nose load (fig 3-2 and table 3-5).

Truck load No. 3 (5-ton truck)—Panel load (fig 3-3 and table 3-6).

Trailer load No. 4 (2½-ton trailer)—Transom load (fig 3-4 and table 3-7).

Truck load No. 5 (5-ton truck)—Deck load (fig 3-5 and table 3-8).

Truck load No. 6 (5-ton truck)—Ramp load fig 3-6 and table 3-9).

Trailer load No. 7 (2½-ton trailer)—Footwalk load (fig 3-7 and table 3-10).

Truck load No. 8 (5-ton truck)—Spares load (fig 3-8 and table 3-11).

Truck load No. 9 (5-ton truck)—Overhead bracing load (fig 3-9 and table 3-12).

Truck load No. 10 (5-ton truck)—Crib-pier load (table 3-13).

Figure 3–1. Truck load No. 1—Parts and grillage load on 5-ton truck.

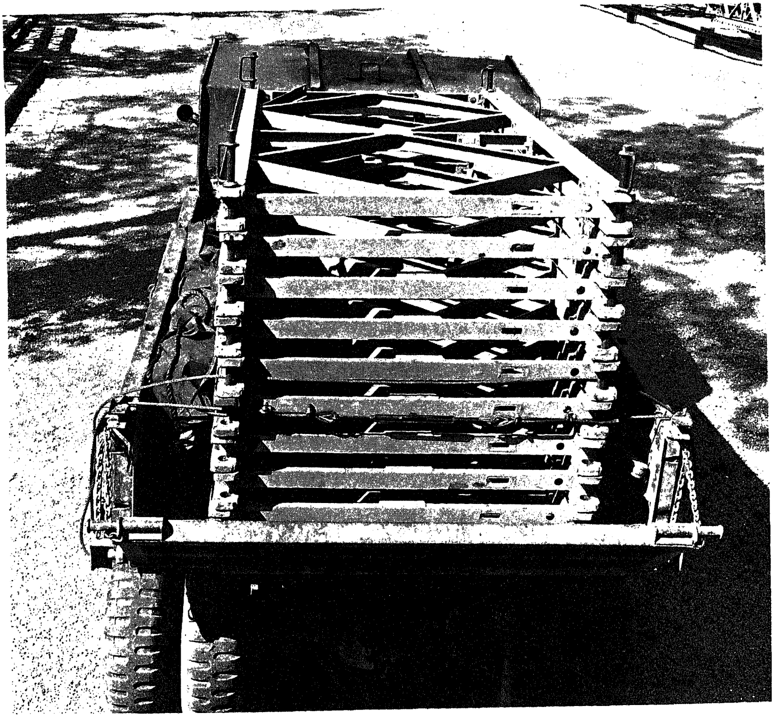


Figure 3–2. Truck load No. 2—Launching nose load on 5-ton truck.

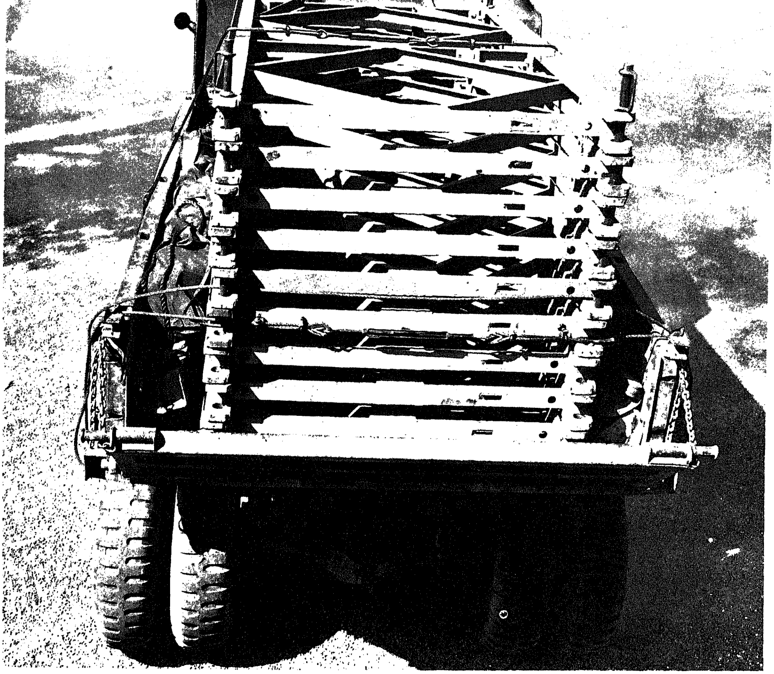


Figure 3–3. Truck load No. 3—Panel load on 5-ton truck.

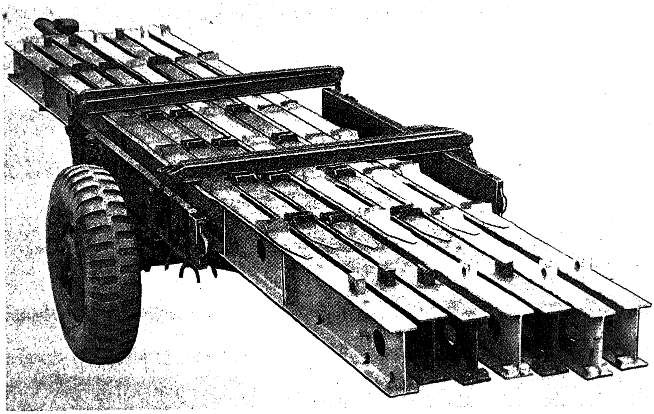


Figure 3–4. Trailer load No. 4—Transom load on 2½-ton pole type trailer.

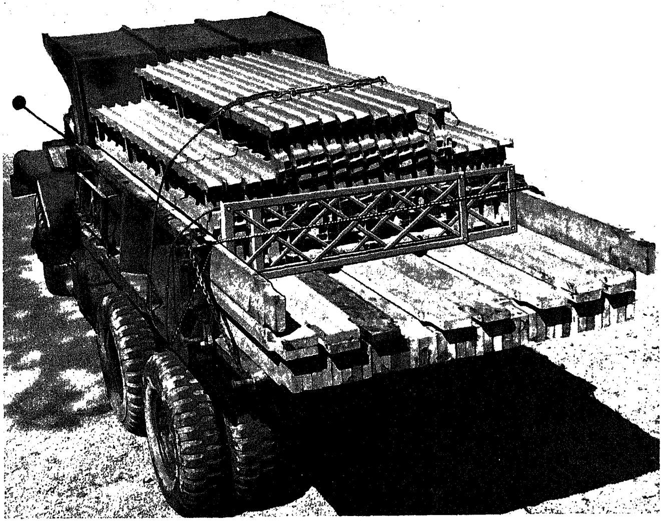


Figure 3–5. Truck load No. 5—Deck load on 5-ton truck.

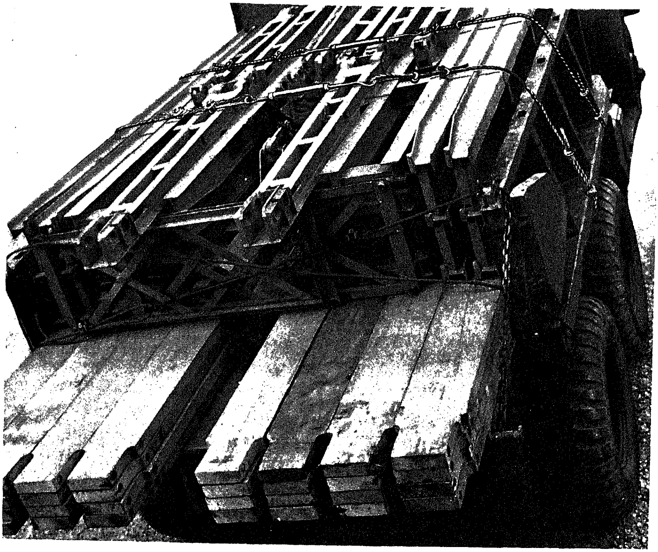


Figure 3–6. Truck load No. 6—Ramp load on 5-ton truck.

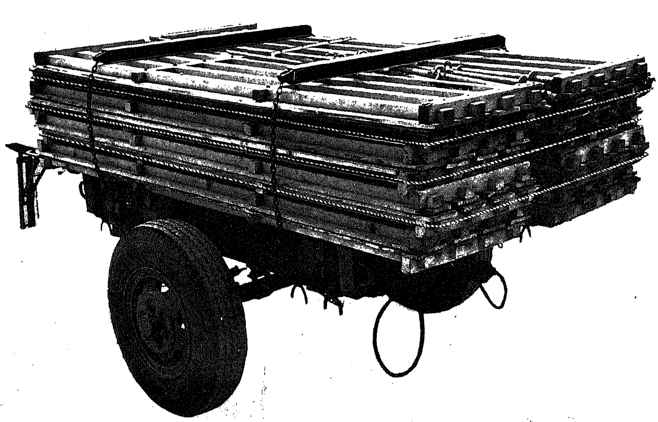


Figure 3–7. Trailer load No. 7—Footwalk load on 2½-ton pole type trailer.

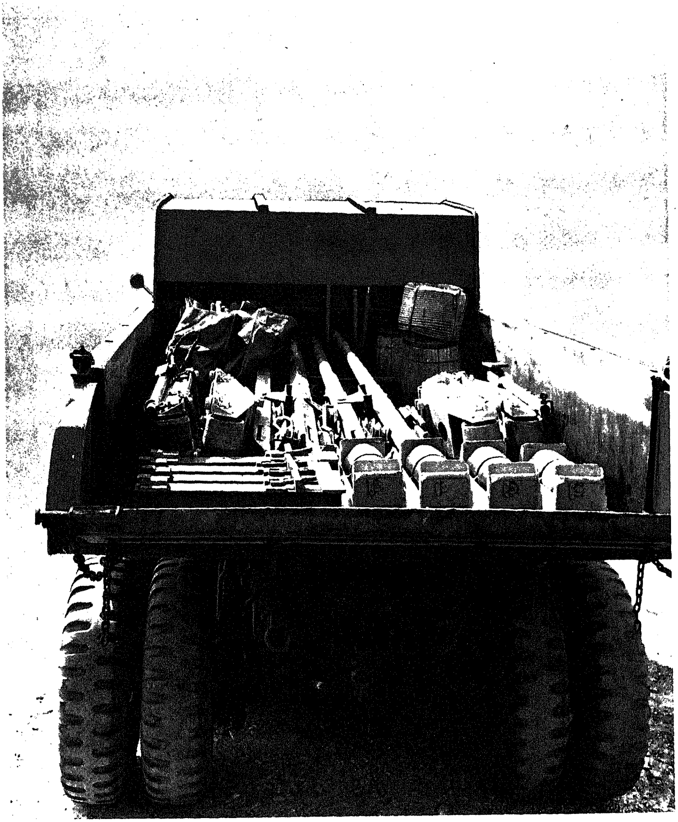


Figure 3–8. Truck load No. 8—Spares load on 5-ton truck.

Quantity	Item	Unit	Total
4	Block, double, for ¾″ rope	8	32
2	Block, triple, for 1″ rope	20	40
2	Block, snatch, for ¾″ rope	6.3	13
2	Box, Wood	60	120
2	Extractor, pin	18	36
5	Hammer, rubber-faced	4	20
2	Jack, ratchet-lever, 15-ton	128	256
2	Jack, chord	82	164
4	Lever, panel	48	192
24	Lumber, 3″ x 6″ x 4′6″	18	432
72	Lumber, 6″ x 6″ x 4′6″	52	3,744
50	Marker, self-luminous	0.13	7.0
100 lb	Nail, wire, steel		100
6	Pickets, steel	12	72
19	Pin, connector, panel, 7 9/16″ long	5.8	110
21	Plate, tie	3.5	74
4	Plate, base, bearing	381	1,524
4	Roller, plain	116	464
4	Roller, rocking	206	824
2	Roller, transom	12	24
8	Shoe, bearing, 4 15/16″	68	528
4	Shoe, jack	36	144
4	Sledge, blacksmith 8 lb	8	32
2	Sign box, interior illuminated, electric.	6	12
10	Spike, ⅜″ x 8″		10
4	Template, rocking roller	78	312
6	Template, roller plain	22	132
8	Tongs, carrying	13	104
2	Wire rope assembly	12	24
6	Wrench, ratchet, reversible	13	78
8	Wrench, socket, offset 90°	12	96
12	Wrench, structural, 1⅛″ for ¾″ bolts.	2	24
6	Wrench, structural, 1½″ for 1″ bolts.	4.7	27
8	Wrench, structural, 1⅞″ for 1¼″ bolts.	5.6	45
	Total		9,816

Quantity	Item	Weight (lb) Unit	Total
3	Bag, Bailey bridge parts and tools.	2	6
3	Bar, carrying	8	24
80	Bolt, bracing, bridge	1	80
26	Bolt, connector, chord	7.5	195
8	Brace, sway	68	544
40	Clamp transom	7	280
2	Hammer, rubber faced	4	8
12	Link, launching nose MK II	28	336
9	Panel, truss bridge	577	5193
2	Picket, steel	12	24
65	Pin, safety, steel	0.13	8.5
30	Pin, connector, panel, 8 15/16″ long	6.1	183
10	Raker, side, strut	22	220
6	Wrench, ratchet, reversible with 1⅛″ and 1⅞″ sockets, for ¾″ and 1¼″ bolts.	13	78
8	Wrench, socket, offset 90° 1⅛″ for ¾″ bolts.	12	96
12	Wrench, structural, 1⅛″ for ¾″ bolts.	2	24
6	Wrench, structural, 1½″ for 1″ bolts.	4.7	28
8	Wrench, structural, 1⅞″ for 1¼″ bolts.	5.6	45
	Total		7373

Note. One transom lcad No. 4 is towed by each launching ncse lcad.

Table 3–6. Truck Load No. 3—Panel Load (5-ton Truck)—(6 Loads Per Bridge Platoon; 12 Loads Per Company)

Quantity	Item	Weight (lb) Unit	Total
3	Bags, Bailey bridge parts and tools.	2	6
3	Bar, carrying	8	24
30	Bolt, riband, guardrail "J"	4.5	135
80	Bolt, bracing, bridge	1	80
26	Bolt, connector, chord	7.5	195
4	Brace, sway	68	272
40	Clamp, transom	7	280
4	Frame, bracing, bridge	44	156
2	Hammer, rubberfaced	4	8
9	Panel, truss, bridge	577	5193
2	Picket, steel	12	24
65	Pin, safety steel	0.12	8.5
26	Pin, connector, panel, 8 15/16″ long.	6.1	159
4	Raker, side, strut	22	88
4	Riband, guardrail	162	648
	Total		7277

Note. 1. One lɔad 3 carries sufficient panels for 2 bays of DS bridge.
2. Riband is carried on 4 trucks/platocn.
3. One truck/cɔmpany carries no rakers or carrying bars.
4. Ea·ch of 3 panel loads tow transom loads.

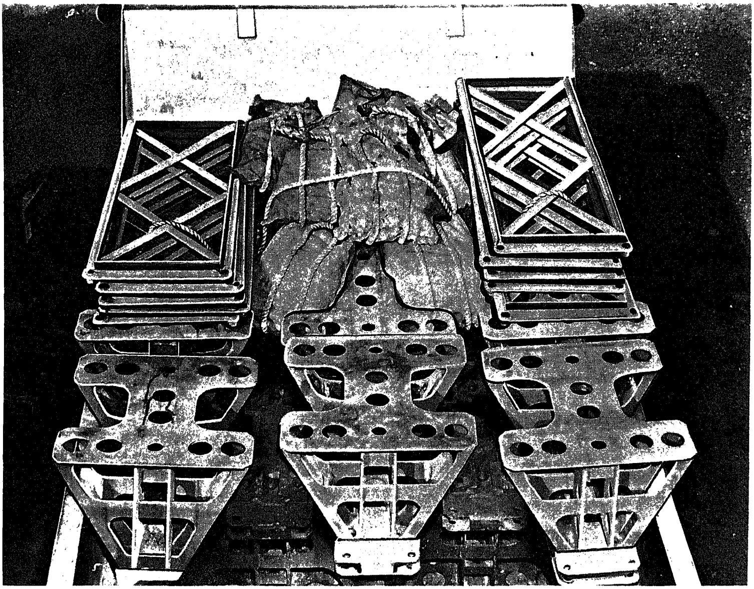


Figure 3–9. Truck load No. 9—Overhead bracing load on 5-ton truck.

Quantity	Item	Weight (lb)	
		Unit	Total
7	Transom, trestle	618	4326
	Total		4326

Table 3-8. Truck Load No. 5—Deck Load (5-ton Truck)—(2 Loads Per Bridge Platoon; 4 Loads Per Company)

Quantity	Item	Weight (lb)	
		Unit	Total
52	Chess, M2	65	3,380
2	Frame, bracing bridge	44	88
8	Stringer, button	267	2,136
16	Stringer, plain	260	4,160
	Total		9764

Table 3-9. Truck Load No. 6—Ramp Load (5-ton Truck)—(2 Loads Per Bridge Platoon; 4 Loads Per Company)

Quantity	Item	Weight (lb)	
		Unit	Total
2	Bag, Bailey bridge parts and tools	2	4
20	Bolts, riband, guardrail "J"	4.5	90
32	Chess, M2	65	2,080
2	Frame, bracing, bridge	44	88
2	Jacks, rachet-level, 15-ton	128	256
4	Pedestal, ramp	93	372
4	Post, end, female	130	520
4	Post, end, male	121	484
4	Ramp, button	348	1,392
8	Ramp, plain	338	2,704
4	Riband, guardrail	162	648
4	Wedge, wood	12	48
	Total		8,686

Note. One load carries no jacks.

Table 3-10. Trailer Load No. 7—Footwalk Load (2½ ton Pole Type Trailer)—(1 Load Per Bridge Platoon; 2 Loads Per Company)

Quantity	Item	Weight (lb)	
		Unit	Total
40	Bearer, footwalk	23	920
16	Footwalk	104	1,664
40	Post, footwalk	10	400
2	Rope, sisal ⅝" x 150", handrail	20	40
	Total		3,024

Quantity	Item	Weight (lb)	
		Unit	Total
1	Bar, carrying	8	8
80	Bolt, bracing, bridge	1	80
36	Bolt, connector, chord	7.5	270
24	Bolt, end post, spares	0.75	18
40	Clamp, transom	7	280
7	Hammer, rubber faced	4	28
12	Holdfast, w/9 pickets	160	1,920
8	Jack, chord	82	656
4	Lever, panel	48	192
100	Nail, wire, steel		100
90	Pin, safety, steel	0.13	12
28	Pin, connector, panel, 8$^{15}/_{16}$" long	6.1	171
50	Pin, sway brace	1.1	55
4	Roller, plain	116	464
4	Roller, rocking	206	824
2	Rope, sisal, ¾" x 600"	102	204
2	Rope, sisal, 1" x 600"	156	312
88	Rope, sisal, lashing, ⅝" x 25"	3.3	290
4	Shackle, anchor type	5	20
4	Sledge, blacksmith 8 lb	8	32
4	Tongs, carrying, bridge erection	13	42
6	Wrench, ratchet, reversible	13	78
8	Wrench, socket, offset 90°	12	96
12	Wrench, structural, 1⅛" for ¾" bolts.	2	24
6	Wrench, structural, 1½" for 1" bolts	4.7	29
8	Wrench, structural, 1⅞" for 1¼" bolts.	5.6	45
	Total		6,250

Table 3-12. Truck Load No. 9—Overhead Bracing Load (5-ton Truck)

Quantity	Item	Weight (lb)	
		Unit	Total
13	Bag, transport	2	26
60	Bolt, bracing (in bag)	1	60
144	Bolt, chord (12 per bag)	7.5	1,080
16	Brace, sway M2*	68	1,088
10	Frame, bracing	44	440
20	Support, overhead-bracing**	150	3,000
	Total		5,694

*Two loads required for a triple-story bridge. 200' long (w/o spares).
**Overhead-bracing supports, set stock number 79.8361.500.500, are not included in bridge sets. They are class IV equipment and must be requisitioned separately. When overhead-bracing supports are not used and triple-story bridges are braced by underslung transoms in inverted third-story panels, overhead-bracing loads are eliminated and 13 sway braces are added to each transom load. Total transom load then weights 6,220 pounds.

d. Loads for Conversion Set No. 3. Conversion set No. 3 is carried in 2 crib-pier loads.

e. Master Tables.

(1) Table 3-14 gives bridge assembly capabilities of the standard truck loads.

*Table 3-13. Truck Load No. 10—Crib-Pier Load—(5-ton Truck)**

Quantity	Item	Weight (lb) Unit	Weight (lb) Total
15	Bag, transport	2	30
12	Bearing, crib	37	444
3	Bearing, junction-link	217	651
18	Bolt, bracing (in bag)	1	18
4	Bolt, chord (in bag)	7.5	30
6	Brace, sway, M2	68	408
6	Capsill, crib	251	1,506
2	Chess, junction, M2	149	298
16	Clamp, chord (in 5 bags)	11	176
16	Clamp, transom (in 2 bags)	7	112
2	Frame, bracing	44	88
3	Link, junction	36	108
3	Link, launching-nose, Mk II	28	84
60	Pin, panel (in 5 bags)	6	360
100	Pin, safety (in bag)	0.1	10
1	Pin, sway-brace, spare (in bag with chord bolts).	1	1
8	Plate, tie	3.5	28
3	Post, junction, span, female	202	606
3	Post, junction, span, male	194	582
8	Raker	22	176
	Total		5,916

*Two loads transport one conversion set No. 3, which combined with standard bridge parts will provide one panel crib pier.

(2) Table 3-15 gives the number of standard truck loads required to assemble each type and size of bridge.

(3) Table 3-16 gives the number of loads required to build each type of crib pier.

Table 3-14. Capabilities of Standard Truck Loads

No.	Name	Loads required
1	Parts and Grillage Load.	Provides site layout and erection equipment.
2	Launching Nose Load.	Provides sufficient equipment for launching nose for 80′ DS bridge, with erection tools (less one panel).
3	Panel Load	Provides sufficient panels for 2 bays DS bridge.
4	Transom Load	Each load No. 4 has sufficient transoms for 3 bays DS bridge.
5	Deck Load	Provides sufficient stringers and chess for 4 bays.
6	Ramp Load	2 per bridge (20′ of ramp at each end).
7	Footwalk Load	1 per 80′ of bridge (one walk on each side).
8	Spares Load	1 per bridge 30′–70′ long. 2 per bridge 80′–150′ long. 3 per bridge 160′–200′ long.
9	Overhead Bracing Load.	2 per triple story bridge.
10	Crib Pier Load	See table 3-16.

Table 3-15. Number of Standard Truck Loads for Different Spans and Assemblies

Span	Type	Number of truck loads: Parts and grillage load* No. 1	Launching nose load No. 3	Panel load No. 3	Transom load No. 4	Deck load No. 5	Ramp load No. 6	Footwalk load No. 7	Spares load No. 8	Overhead bracing load No. 9	Total vehicles: 5-ton dump load No. 9	2½-ton pole trailers
30	SS	1	1	1	2	1	4	1	1		9	3
40	SS	1	1	1	2	1	4	1	1		9	3
50	SS	1	1	2	2	2	4	1	1		12	3
	DS	(**)	1	3	4	2	4	1	1		14	5
60	SS	1	1	2	3	2	4	1	1		11	4
	DS	(**)	1	3	3	2	4	1	1		13	4
70	SS	1	1	2	3	2	4	1	1		11	4
	DS	1	1	4	4	2	4	1	1		13	5
80	SS	1	1	2	4	2	4	1	2		12	5
	DS	1	1	4	4	2	4	1	2		14	5
	TS	(**)	1	6	6	2	4	1	2		18	7
90	SS	1	2	2	4	3	4	2	2		14	6
	DS	1	2	4	4	3	4	2	2		16	6
	TS	(**)	2	6	4	3	4	2	2		19	6
100	SS	1	2	3	3	3	4	2	2		15	5
	DS	1	2	5	3	3	4	2	2		17	5
	TS	1	2	7	4	3	4	2	2		19	6
	DD	(**)	2	9	7	3	4	2	2		23	9
110	DS	1	2	5	5	3	4	2	2		17	7
	TS	1	2	8	5	3	4	2	2		20	7
	DD	(**)	2	10	8	3	4	2	2		24	10
	TD	(**)	2	15	8	3	4	2	2		29	10
120	DS	1	2	6	5	3	4	2	2		18	7
	TS	1	2	9	5	3	4	2	2		21	7
	DD	(**)	2	11	5	3	4	2	2		25	7
	TD	(**)	2	16	8	3	4	2	2		30	10

See notes below table.

Span	Type	grillage load* No. 1	nose load No. 3	load No. 3	load No. 4	load No. 5	load No. 6	load No. 7	load No. 8	bracing load No. 9	dump load No. 9	pole trailers
130	DS	1	2	6	5	4	4	2	2	-------	19	7
	TS	1	2	9	5	4	4	2	2	-------	22	7
	DD	2	2	12	5	4	4	2	2	-------	26	7
	TD	(**)	3	18	5	4	4	2	2	-------	34	7
	DT	(**)	3	18	9	4	4	2	2	2	33	11
140	DS	1	2	7	6	4	4	2	2	-------	20	8
	TS	2	2	10	6	4	4	2	2	-------	24	8
	DD	2	3	13	6	4	4	2	2	-------	28	8
	TD	(**)	3	18	6	4	4	2	2	-------	34	8
	DT	(**)	3	18	9	4	4	2	2	2	33	11
160	TS	1	2	10	6	4	4	2	2	-------	23	8
	DD	(**)	3	14	6	4	4	2	2	-------	30	8
	TD	(**)	3	20	6	4	4	2	2	-------	36	8
	DT	(**)	3	20	6	4	4	2	2	2	38	8
160	TS	1	2	11	6	4	4	2	3	-------	25	8
	DD	2	3	15	6	4	4	2	3	-------	31	8
	TD	(**)	3	22	6	4	4	2	3	-------	39	8
	DT	(**)	4	22	6	4	4	2	3	2	39	8
	TT	(**)	4	32	11	4	4	2	3	2	49	13
170	DD	(**)	3	18	7	5	4	3	3	-------	36	10
	TD	(**)	4	26	7	5	4	3	3	-------	45	10
	DT	(**)	4	26	7	5	4	3	3	2	44	10
	TT	(**)	4	38	12	5	4	3	3	2	56	15
180	DD	2	3	19	7	5	5	3	3	-------	36	10
	TD	(**)	4	28	7	5	4	3	3	-------	47	10
	DT	(**)	4	28	7	5	4	3	3	2	46	10
	TT	(**)	4	40	7	5	4	3	3	2	58	10
190	TD	(**)	4	28	8	5	4	3	3	-------	47	11
	DT	(**)	4	28	8	5	4	3	3	2	49	11
	TT	(**)	4	42	8	5	4	3	3	2	60	11
200	DT	(**)	4	31	8	5	4	3	3	2	52	11
	TT	(**)	4	44	8	5	4	3	3	2	62	11
210	DT	(**)	4	32	8	6	4	3	3	2	54	11
	TT	(**)	4	46	8	6	4	3	3	2	68	11

*Grillage requirements based on soil with a safe bearing pressure of 2 tons per square foot.
**These bridges require grillages which do not use materials supplied in the parts and grillage load.
Note. Grillage supplied must be increased if cribbing is needed on top of standard grillage types and under plain roller templates.

3–3. Bay Loads

The recommended bridge load for combat operations is the bay load (fig 3–10 and 3–11). Each truck contains all the parts, except transoms, required for one bay (10 ft) of double-single Bailey bridge. This loading lends itself well to most combat engineer Bailey bridge missions. Table 3–17 lists the parts found in the bay load. Pole type, 2½-ton trailers carry the transoms as with the bridge load mentioned earlier. The bay load is designed to be easily off loaded using a crane. However, the load may also be unloaded by hand or dumped if a crane is not available. If the load is dumped, care should be exercised not to damage the chess. For a complete bridge, parts and grillage, launching nose, ramp, footwalk, spares and overhead bracing loads must also be included.

Table 3-16. Panel Crib Piers That Can be Assembled Using Standard Truck Loads

Pier			Number of standard truck loads			
Height	Type	Position of rocker	Parts load No. 1	Panel load No. 2	Transom load No. 3	Crib pier load No. 9
6′-3½″	SS (1H)	At base of pier	1	1	1	1
7′-2½″	SS (1H)		1	1	1	1
10′-10½″	SS (2V)		1	1	1	1
	DS (2V)		1	1	1	1
11′-2½″	SS (1V)		1	1	1	1
	DS (1V)		1	1	1	1
	TS (1V)		1	1	1	1
11′-7¼″	SS (1V)		1	1	1	1
6′-6½″	SS (1H)	At top of pier	1	1	1	2
	DS (1H)		1	1	1	2
	TS (1H)		1	1	1	2
11′-3″	SS (1V)		1	1	1	2
	DS (1V)		1	1	1	2
	TS (1V)		1	1	1	2
11′-7″	SS (2V)		1	1	1	2
	DS (2V)		1	1	1	2
16′-6½″	SD (1H-1V)		1	1	1	2
	DD (1H-1V)		1	1	2	2
17′-0″	SD (2V-1H)		1	1	1	2
21′-7″	DD (2V-1V)		1	2	1	2
6′-3½″	DS (1H)	At base of pier	1	1	1	2
	TS (1H)		1	1	1	2
7′-2½″	DS (1H)		1	1	1	2
	TS (1H)		1	1	1	2
11′-7¼″	DS (1V)		1	1	1	2
	TS (1V)		1	1	1	2
10′-10½″	TS (2V)		1	2	1	1
11′-7″	TS (2V)	At top of pier	1	2	1	2
16′-6½″	TD (1H-1V)		1	2	1	2
17′-0″	DD (2V-1H)		1	2	1	2
	TD (2V-1H)		1	3	1	2
21′-3″	TD (1V-1V)		1	2	1	2
21′-7″	DD (2V-1V)		1	2	1	2
	TD (2V-1V)		1	3	1	2
	DD (2V-2V)		1	2	1	2
31′-7″	DT (2V-2V-2V)	At top of pier	1	3	2	2
	TT (2V-2V-2V)		1	5	2	2
41′-7″	DQ (4V-4V-2V-2V)		1	6	3	4
51′-7″	D5 (4V-4V-2V-2V-2V)		1	7	4	5
41′-7″	TQ (4V-4V-2V-2V)		1	9	3	6
51′ 7″	T5 (4V-4V-2V-2V2-V)		1	10	4	6

12	Bolt, bracing, bridge	1	12
8	Bolt, riband	4	36
2	Brace, sway	68	136
13	Chess, M2	65	845
8	Clamp, transom	7	56
2	Frame, bracing, bridge	44	88
4	Panel, truss, bridge	577	2,308
8	Retainer, bridge pin	0.13	1.04
8	Pin, connector, panel, long	6.1	48.8
2	Raker, side, strut	22	44
2	Riband, guardrail	162	324
2	Stringer, button	267	534
4	Stringer, plain	260	1,040

Note. **Panel and bridge pin retainers are not included to pin on female end posts.**

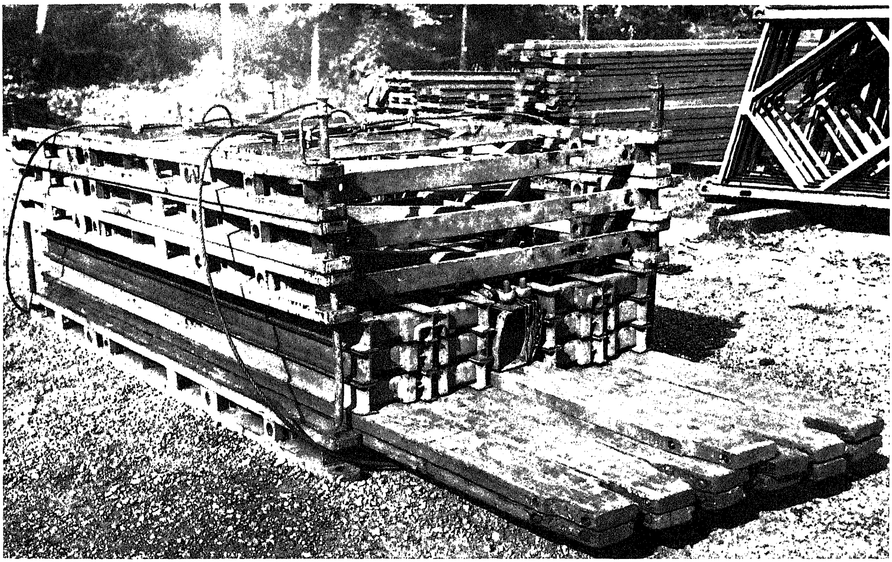


Figure 3–10. Unloaded bay load.

Figure 3–11. Truck bay load.

CHAPTER 4

PLANNING AND ORGANIZATION

4–1. Requirements

Each available bridge site must be reconnoitered to select the site which is most economical in use of available personnel, equipment, and time. The reconnaissance officer must be given the following information before making his reconnaissance:

a. Where Bridge is Needed. The general location of the bridge is determined by tactical requirements.

b. Class of Bridge Needed. The class of the bridge is determined by the type of vehicles it must carry.

c. When Bridge is Needed. The time designated for the bridge to become operational impacts heavily in planning for the mission.

4–2. Preliminary Studies

A thorough evaluation of information from preliminary studies may aid the reconnaissance by limiting it to a few suitable sites. Sources of preliminary information are intelligence studies and reports, interviews with local civilians, maps, aerial photographs (including stereo-pairs), personal aerial reconnaissance.

4–3. Site Selection

Whenever possible a ground reconnaissance is made.

a. Site Selection Factors. The following site selection factors are desirable for a panel bridge,

(1) Access routes at each end of the bridge tying in to the main road net. These routes should not require too much maintenance or preparation.

(2) Approaches requiring little preparation. Should be two lane and straight for 150 feet at each end of the bridge. Slope should not exceed 10 percent (10 to 1).

(3) Firm and stable banks of about equal height.

(4) Assembly site large enough for assembly of the bridge and wide enough for unloading and stacking the parts and erection tools. The approach road often provides such space.

(5) Turnaround area large enough to allow the trucks and pole type trailers to completely turn around so that they can back into the site. Normally located approximately 50 feet from the bridge site.

(6) Engineer equipment park—a covered and concealed area, located from ½ to 5 kilometers behind the bridge site, in which to store vehicles and equipment when not in use at the bridge site.

(7) Special consideration must be given the amount of work required to prepare the approaches and piers, since this work frequently takes as much time as the actual bridge installation.

b. Reconnaissance Report. The reconnaissance report contains a description of every usable site reconnoitered with a recommendation as to the preferred site. The report includes—

(1) Location of site.

(2) Width at gap.

(3) Length, truss type, and type of grillage of bridge that would be assembled at site.

(4) Slope of bridge.

(5) Condition of banks and capacity of abutments.

(6) Proposed location of rocking rollers, plain rollers, and base plates.

(7) Site preparation required.

(8) Recommended method of transporting men and equipment to far bank.

(9) Sketch showing profile of centerline of the bridge, extending 100 feet on the near shore and 50 feet on the far shore.

(10) Sketch showing layout of assembly site, and location of turnaround and engineer equipment park.

(11) Truck route to bridge site from engineer equipment park.

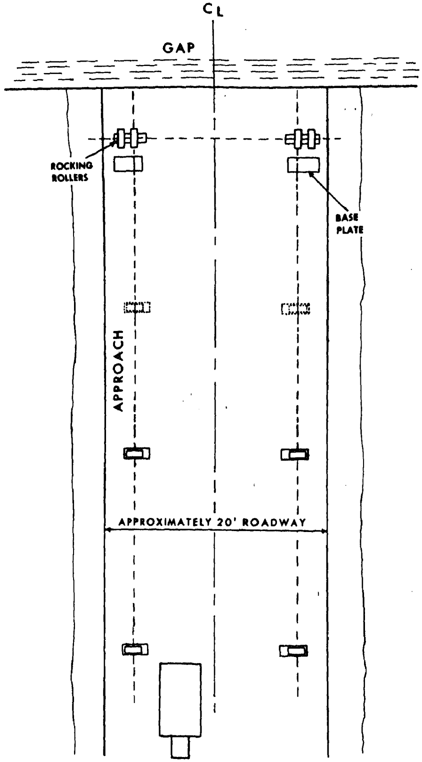


Figure 4–1. Typical bridge site.

4–4. Bridge Design

Field design is outlined in chapter 5.

4–5. Site Layout

a. Assembly Directly from Trucks. Figure 4–1 shows a typical bridge site when the bridging is being unloaded directly from the trucks. The site must be cleared for at least as long as the width of the gap, but the width of the site need only be the width of the approach.

b. Assembly from Bridging Stacked at Site. If the bridging is to be unloaded and stacked at the site, the site must be approximately 150 feet wide. The stacks are arranged as illustrated in figure 4–2. In restricted areas, 30 feet should be available at least on one side of the bridge to permit insertion of transoms. Otherwise, transoms must be threaded from within two bridge truss girders.

4–6. Organization

The work force is normally organized into unloading parties and an assembly party.

a. Unloading Parties. Each consists of one noncommissioned officer and eight men. The number of unloading parties depends on the length and type of the bridge (table 4–1). Unless an unusually large cleared area exists at the site, no more than three or four unloading parties will be able to work efficiently at any one time.

Table 4–1. Number of Unloading Parties Needed

Type	Span (feet)	Number of unloading parties*
SS	30–60	3
	70–90	4
DS	50–80	4
	90–120	5
TS	70–120	5
	130–140	6
DD	90–150	6
	160–170	7
TD	110–120	6
	130–180	7
	190–200	8
DT	130–170	7
	180–200	8
TT	150–200	8

*Each party is 1 NCO and 8 EM.

b. Assembly Party. The various details in the assembly party are shown in table 4–2.

c. Duties. The duties of the details in the assembly party are as follows:

(1) *Panel detail.*

(*a*) Carries, places, and pins together panels in the launching nose and bridge.

(*b*) As soon as all panels are in place, divides into two crews. One crew crosses to far bank and begins dismantling the launching nose. The other carries necessary parts to the far bank for completion of the end of bridge and installation of the ramp.

(*c*) Re-forms as a single detail and completes dismantling of the launching nose.

(*d*) Installs far-bank end posts.

(*e*) Jacks down far end of bridge.

(*f*) Installs far-bank ramp, and places its chess and ribands.

(2) *Transom detail.*

(*a*) Carries, places, and clamps down transoms.

(*b*) Removes plain rollers on near bank.

(*c*) Installs end posts on near bank.

(*d*) Assists decking detail in jacking down near end of bridge.

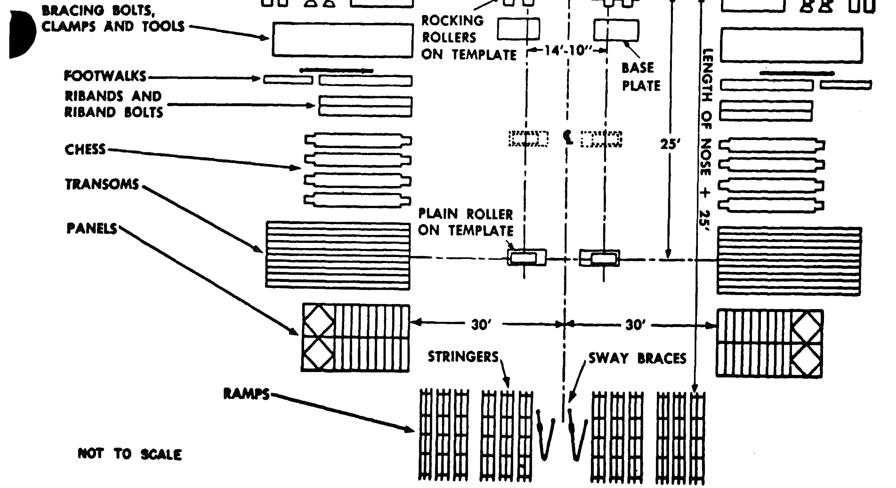


Figure 4-2. Layout of bridging equipment at site.

Table 4-2. Organization of Assembly Party

Detail	Number of NCOs AND EM								
	Type of bridge								
	Single-single	Double-single	Triple-single	Double-double	Triple-double	Double-triple	Triple-triple	Double-triple	Triple-triple
	Construction by manpower only							Using one crane*	
CRANE								0-3	0-3
Truckdriver								(1)	(1)
Crane operator								(1)	(1)
Hook man								(1)	(1)
PANEL	1-14	1-14	2-28	2-32	3-50	3-50	3-68	3-30	3-30
Carrying	(12)	(12)	(24)	(28)	(44)	(44)	(60)	(24)	(24)
Pin	(2)	(2)	(4)	(4)	(6)	(6)	(8)	(6)	(6)
TRANSOM	1-9	1-10	1-10	1-10	1-10	2-28	2-28	2-20	2-20
Carrying	(8)	(8)	(8)	(8)	(8)	(24)	(24)	(16)	(16)
Clamp	(1)	(2)	(2)	(2)	(2)	(4)	(4)	(4)	(4)
BRACING	1-4	1-6	1-8	1-12	1-20	1-32	1-40	1-32	1-38
Sway brace	(2)	(2)	(2)	(2)	(2)	(6)	(6)	(6)	(6)
Raker	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Bracing frame		(2)	(2)	(4)	(4)	(8)	(8)	(10)	(8)
Chord bolt				(4)	(8)	(10)	(14)	(10)	(14)
Tie plate			(2)		(4)		(4)		(4)
Overhead support						(6)	(6)	(4)	(4)
DECKING	1-12	1-12	1-12	1-12	1-12	1-12	1-12	1-12	1-12
Stringer	(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8)
Chess and riband	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Total	4-39	4-42	5-58	5-66	6-92	7-122	7-148	7-97	7-103

* Normally, a crane is not used for single- or double-story assembly.

(*e*) Installs near-bank ramp and assists decking detail in placing chess and ribands on it.

(3) *Bracing detail.* Obtains, installs, and adjusts the following parts:

(*a*) Sway braces.

(*b*) Rakers.

(*c*) Bracing frames, on double- and triple-truss bridges only.

(*d*) Chord bolts, on double- and triple-story bridges only.

(*e*) Tie plates, on triple-truss bridges only.

(*f*) Overhead bracing supports, on triple-story bridges only.

(4) *Decking detail.*

(*a*) Assists panel detail in starting assembly of the launching nose.

(b) Lays stringers, chess, and ribands on bridge.

(*c*) Jacks down near end of bridge.

(d) Lays chess and ribands on near-bank ramp.

4–7. Assembly Time

Time for assembly and installation of a normal bridge is given in table 4–3.

Table 4–3. Estimated Time for Assembly [1]

Length in feet	Type of bridge								
	Single single	Double-single	Triple-single	Double-double	Triple-double	Double-triple	Triple-triple	Double-triple	Triple-triple
	Time in hours								
	Construction by manpower only							Using one crane [3]	
40	1½								
60	1¾	2							
80	2	2½	3						
100	2¼	3	3½	4¼					
120		3½	4	5	6¾				
140		3¾	4½	5¾	7½	11¾		10½	
160			5	6¼	8½	13¼	19	11¾	16¼
180				7	9½	14¾	21¼	13¼	18¼
200						16¼	24	14½	20½

[1] These times assume daylight conditions, a favorable assembly site, trained personnel, equipment stacked at site, and footwalks omitted. Field conditions, use of untrained troops, poor weather, and enemy activity lengthen assembly time. For blackout conditions, increase daylight times by 50 percent, untrained troops, 20 percent, poor weather, 30 percent.

[2] Time does not include preparation of site and layout of rollers. Clearing and leveling of site and roller layout will take from ½ to 4 or more hours depending upon amount of work required to level site, construct grillages, and crib up rollers.

[3] Normally, a crane is not used for single- or double-story construction.

a. Daylight Conditions

(1) *Assembly and launching.* Table 4–3 shows estimated times for daylight assembly and launching of various lengths of different types of bridges when built by manpower alone and when one crane is used. Times do not include preparation of site and layout of rollers. These times assume that there is a favorable assembly site, that trained personnel are available, that equipment is stacked at the site, and that footwalks are omitted. Use of untrained troops, poor weather, various terrain conditions, and enemy activity will lengthen assembly time. Additional time must also be allowed for placing wear treads.

(2) *Roller layout.* Add ½ to 4 or more hours for preparation of site and layout and placing of rollers (depending upon the amount of work required to level site, install grillages, and crib up rollers).

(3) *Unloading.* Add ½ hour for unloading from trucks if separate unloading parties are available. If not available, add 1 to 2½ hours according to type of bridge.

b. Blackout Conditions. For blackout conditions, increase daylight times by 50 to 100 percent depending upon how much illumination of the site is allowed by the tactical situation. As a rough rule of thumb, once the site is cleared and the area for roller layout is leveled, under minimum illumination of the site, the total time to accomplish roller layout, bridge assembly, launching, jackdown, and ramp installation is one bay of bridge per hour.

4–8. Installation Procedure

a. Site preparation—clearing mines, removing obstacles, etc. Constructing a turnaround for trucks.

b. Roller layout (and installation of base plates).

c. Unloading of bridging.

f. Laying of wear treads.

g. Footwalks.

bridge equipment, without confusion, when it is needed. If the equipment is to be stacked at the site, the transportation is timed to arrive as soon as the stacking site is ready.

CHAPTER 5

FIELD DESIGN AND CLASSIFICATION

Section I. LENGTH, TRUSS TYPE, AND GRILLAGE TYPE

5–1. General

The Bailey bridge may be adapted to fit almost any gap. The field design procedure first determines the initial length of bridge required. The truss type needed to carry the required class of traffic is then determined. Finally the required grillage is determined. However, the grillage type may cause a change to the initially determined bridge length. If so, truss type will have to be rechecked, as well as the grillage type, for the new bridge length.

5–2. Determination of Initial Bridge Length

The initial bridge length is determined by adding the width of the gap, the distance that the rocking rollers must be set back from the edge of the bank (safety setback) and the distance from the center of the rocking roller to the bearing on which the end of the bridge will rest (roller clearance).

a. Gap. The measurement of the gap depends on the condition of the abutments.

(1) *Prepared abutments.* Prepared abutments are considered to be abutments which can hold the bridge load close to the face without failing. Examples of prepared abutments are mass concrete, headwall with piles, and headwall with footers and deadman. TM 5–312 gives more detailed information on prepared abutments. The gap is measured between the faces of two prepared abutments (fig 5–1).

(2) *Unprepared abutments.* An unprepared abutment is one which would probably fail if the bridge load were applied close to its edge. Examples of unprepared abutments would be natural slopes, demolished abutments, or abutments with headwalls which are not strong enough to hold the load. The gap is measured from the toe of the slope of one unprepared abutment to the toe of the slope of the other (fig 5–2).

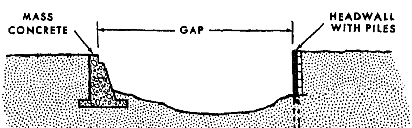


Figure 5–1. Measuring the gap with two prepared abutments.

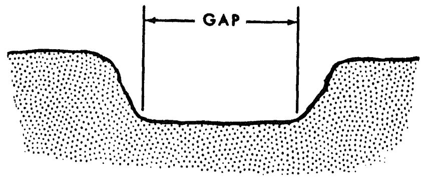


Figure 5–2. Measuring the gap with two unprepared abutments.

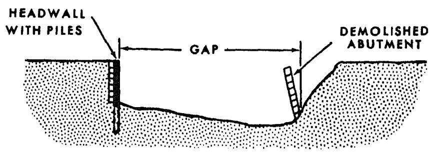


Figure 5–3. Measuring the gap with one prepared and one unprepared abutment.

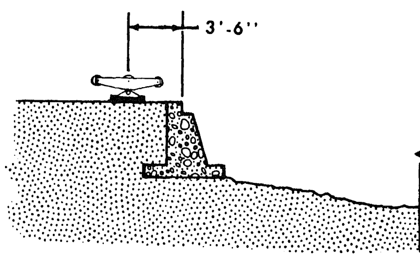


Figure 5–4. Safety setback for prepared abutments.

of the prepared abutment to the toe of the slope of the unprepared abutment (fig 5–3).

b. *Safety Setback.* Safety setback is the minimum distance that each rocking roller must be behind the bank of the gap. This distance depends on the condition of the abutments on each bank.

(1) *Prepared abutments.* If the bridge site has prepared abutments, the rocking rollers are set back a minimum of 3 feet 6 inches from the edge of the abutment (fig 5–4).

(2) *Unprepared abutments.* When unprepared abutments exist, the safety setback must be calculated. If the rollers are placed too close to the edge of the gap, the soil may fail during launching. The rocking rollers are therefore placed at a location behind the angle of repose of the soil. For field design, the angle of repose is assumed to be 45° (an average value). This would mean that the rocking roller should be set back a distance equal to the height of the bank. However, an additional safety factor of 50 percent is added. Therefore the safety setback is established as 1.5 times the bank height. The bank height is measured from the toe of the slope to the ground level at the abutment (fig 5–5). The safety setback is measured back from the toe of the slope.

Example: Given: Unprepared abutment
Bank height 8′
Required: Determine the safety setback

c. *Roller Clearance.* Roller clearance is the distance from the center of the rocking roller to the center of the bearing on which the bridge end posts will rest (fig 5–6). The normal roller clearance approximately 2 feet 6 inches. This figure is always used when determining the initial bridge length. If grillage is required, the actual roller clearance will be determined by the type of grillage used (fig 5–10—5–17).

d. *Bridge Length.* The initial bridge length is the sum of the width of the gap, the safety setbacks, and the roller clearances.

Examples.

(1) Both abutments prepared (fig 5–7).
Given: Gap is 56 feet (abutment to abutment)
Required: Determine initial bridge length

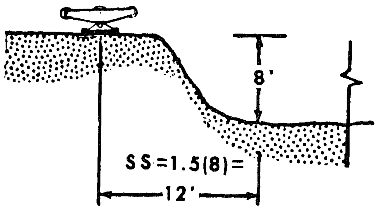


Figure 5–5. Safety setback for unprepared abutments.

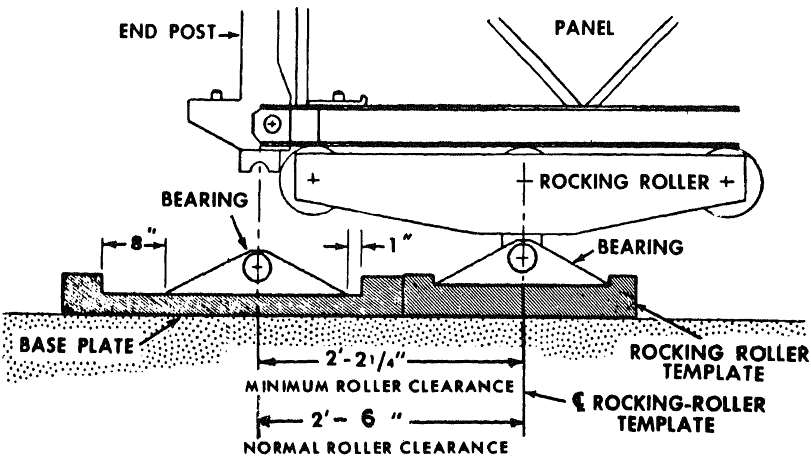


Figure 5–6. Rocking rollers and base plate at the end of bridge.

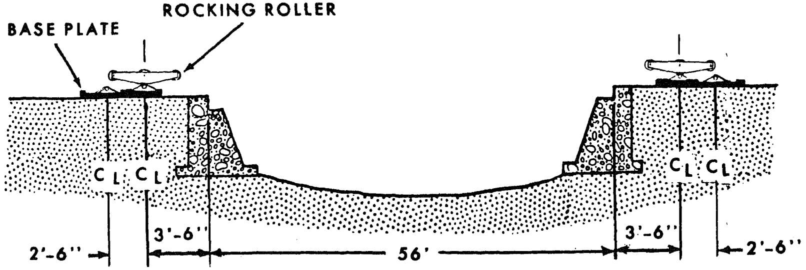


Figure 5–7. Profile of bridge site—both abutments prepared.

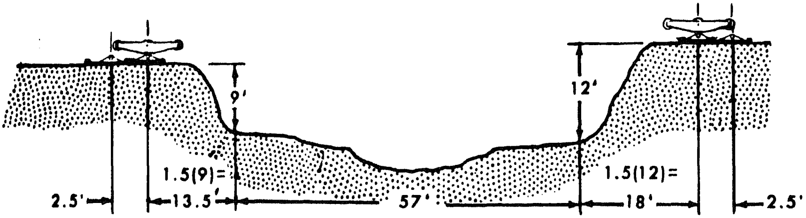


Figure 5–8. Profile of bridge site—both banks without prepared abutments.

Solution: Initial bridge length = gap + safety setbacks + normal roller clearances

$L_i = 56' + (3.5' + 3.5') + (2.5' + 2.5')$

$L_i = 68'$

Round up to the next 10-foot length—70'

(2) Both abutments unprepared (fig 5–8).

Given: Gap measurement (toe to toe)—57'
Bank height—near shore 9', far shore 12'

Required: Determine initial bridge length

Solution: L = gap + safety setbacks + roller clearances

$L = 57' + [1.5(9) + 1.5(12)] + (2.5 + 2.5)$

$L = 93.5$ Round up to 100 feet

(3) One prepared and one unprepared abutment (fig 5–9).

Given: Gap measurement (toe to toe)—53'
Bank height unprepared shore—10'

Required: Determine initial bridge length

Solution: L = gap + safety setbacks + roller clearances

$L = 53 + [3.5 + 1.5(10)] + (2.5 + 2.5)$

$= 76.5'$ Round up to 80'

5–3. Truss Type

The required truss type for a given length of Bailey bridge to carry a specified class of traffic is found in table 5–1. The actual class of the bridge may be greater than required, but not less.

Note. The truss type required for a *normal* crossing is always used.

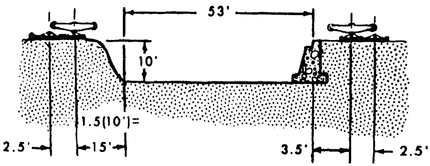


Figure 5–9. Profile of bridge site—one prepared abutment and one bank without prepared abutment.

Table 5-1. Classes of Bailey Bridge M2 (By Type of Construction and Type of Crossing)

Bridge length (feet)	SS			DS			TS			DD			TD			DT			TT		
	N	C	R	N	C	R	N	C	R	N	C	R	N	C	R	N	C	R	N	C	R
30	30/ /30	42/ /37	47/ /42																		
40	24/ /	36/ /34	40/ /38																		
50	/ /24	33/ /31	36/ /35	75/ /70	83/ /76	88/ /84															
60	20/ /	30/ /29	33/ /32	(5/ /65	77/ /73	85/ /79															
70	20/ /	24/ /	30/ /30	60/ /60	68/ /69	78/ /75															
80	16/ /	20/ /	24/ /	50/ /55	60/ /60	66/ /64	85/ /80	95/ /90	100*/ /90*												
90	12/ /	16/ /	19/ /	40/ /45	50/ /50	55/ /55	65/ /65	74/ /75	82/ /82												
100	8/ /	12/ /	14/ /	30/ /30	37/ /39	42/ /44	50/ /55	57/ /60	64/ /66	80/ /80	86/ /90	96/ /90									
110				20/ /	30/ /32	34/ /36	35/ /40	47/ /49	52/ /54	65/ /70	72/ /76	80/ /83	90/ /90*	100*/ /90*	100*/ /90*						
120				16/ /	23/ /	27/ /30	30/ /35	38/ /41	43/ /45	45/ /55	57/ /61	64/ /68	75/ /80	83/ /90*	91/ /90*						
130				12/ /	18/ /	21/ /	20/ /	31/ /33	35/ /38	35/ /45	47/ /50	53/ /56	55/ /60	65/ /72	74/ /80	70/ /80	80/ /90*	90/ /90*			
140				8/ /	14/ /	17/ /	16/ /	24/ /	29/ /31	30/ /35	39/ /42	44/ /48	45/ /55	57/ /62	64/ /70	70/ /70	80/ /90*	88/ /90*			
150							12/ /	18/ /	22/ /	24/ /	32/ /35	36/ /40	35/ /45	47/ /51	54/ /58	60/ /60	77/ /85	85/ /90*			
160							8/ /	15/ /	17/ /	16/ /	25/ /	30/ /33	30/ / 35	37/ /41	45/ /48	55/ /55	69/ /78	80/ /89	80/ /75	100/ /90*	100 /9
170							4/ /	10/ /	13/ /	12/ /	19/ /	24/ /	20/ /	31/ /34	37/ /40	45/ /50	57/ /64	64/ /74	70/ /70	80/ /90*	90 /9
180										8/ /	15/ /	18/ /	16/ /	24/ /	29/ /32	35/ /45	48/ /58	55/ /60	55/ /60	66/ /75	77 /8

Table 5-1. Classes of Bailey Bridge M2 (By Type of Construction and Type of Crossing)—Continued

Bridge length (feet)	SS			DS			TS			DD			TD			DT			TT		
	N	C	R	N	C	R	N	C	R	N	C	R	N	C	R	N	C	R	N	C	R
190													12/ /	18/ /	22/ /	30/ /35	39/ /43	46/ /51	45/ /55	59/ /66	68/ /77
200																20/ /	32/ /36	38/ /43	35/ /40	48/ /52	55/ /62
210																16/ /	25/ /	31/ /35	24/ /	38/ /43	46/ /51

Notes. 1. N = Normal, C = Caution, R = Risk.
*2. Limited by Roadway Width.
3. Upper figure represents wheel load class.
Lower figure represents tracked load class. *Example:* 46/51
4. Bridges which have a normal rating over class 70 must be constructed with double transoms.
5. Single classification is designated below class 30.
6. Cribbing and wedges are used under the middle of end transoms in bridges of class 40 or over.
7. Cribbing and wedges are placed under the midspan of ramps on bridges of class 45 or over.

Required: Determine the truss type required
Solution: From table 5–1
Truss type—triple—single
Actual class—85 wheel/80 track

5–4. Type of Grillage Required

a. Purpose. The end posts at each end of the bridge are supported by bearings set on base plates (fig 2–18 and 5–6). During launching, the entire launching weight of the bridge is carried by the near bank rocking rollers, which rest on rocking-roller templates. If the bearing pressure under the rocking-roller template (or base plate) exceeds the safe bearing capacity of the ground, grillages are used to spread the load over a larger area (fig 5–10—5–17). Grillages also serve as cribbing to raise base plates or rollers to the desired level.

b. Description. Grillages are made of squared timbers laid under the base plate or roller template. These must be carefully leveled transversely; grillages on each end of the bridge must be level with each other so that all trusses will rest on bearing plates. If bearing plates are not level transversely only one truss will carry the load at first, until deflection under load brings the other trusses to bear. The first truss to bear will then be overstressed before the last truss can be fully utilized. This can result in failure under less than the rated load of the bridge.

(1) *Standard grillages using timbers supplied in panel bridge set.* The panel bridge set supplies 144 each 6- by 6-inch timbers 4½ feet long, and 48 each 3- by 6-inch timbers 4½ feet long for grillage. Standard grillages using these timbers and panel bridge parts are illustrated in figures 5–10 through 5–14. The capacities are given in table 5–4.

(2) *Grillages using timbers not supplied in panel bridge set.* On soft soils, some of the heavier bridges will require larger grillages than can be built from the timbers supplied in the set. For these bridges, grillages built from 8- by 8-inch timbers are shown in figures 5–15 through 5–17.

(3) *Nonstandard grillages.* Other size timbers can be used if each layer is at least as thick and as wide as the corresponding standard grillage. Squared timbers should be used so far as possible. Use of rough cut timbers often results in uneven, wobbly cribs.

the soil bearing capacity. Table 5–2 gives the safe bearing pressure in tons per square foot on various soils. A careful evaluation of the soil character is essential to prevent grillage failures. Note that in sandy or gravelly soils, the bearing power of the soil is increased when the grillage is dug in so that it bears on the soil 1½ or more feet below the surrounding surface.

Table 5–2. Safe Bearing Capacity for Various Soils

Soil description	Bearing values in tons per square foot
Hardpan overlying rock	12
Very compact sandy gravel	10
Loose gravel and sandy gravel, compact sand and gravelly sand; very compact sand, inorganic silt soils.	6
Hard dry consolidated clay	5
Loose coarse to medium sand; medium compact fine sand.	4
Compact sand clay	3
Loose fine sand; medium compact sand, inorganic silt soils.	2
Firm or stiff clay	1.5
Loose saturated sand clay soils; medium soft clay	1

(2) *Load on grillage.* Table 5–3 gives the load on grillage at one corner of the bridge. Note that in some bridges the rocking roller reaction is greater than the base-plate reaction.

(3) *Capacities of grillage.* Table 5–4 gives the load capacities for the grillage in varying soils.

(4) *Determining required grillage.* The type of grillage required may be found by determining the bridge reactions from table 5–3 and then selecting a grillage type from table 5–4 which has the required capacity for the proper soil type. The grillage types for various soils and bridge types are also given in table 5–5.

Example:
Given: Bridge length—80′
Truss type—triple single
Soil type—loose fine sand
Required: Determine the grillage type required.
Field solution: (1) From table 5–2, soil bearing capacity is 2 tons/foot.
(2) From table 5–5, grillage type required is type 4.

Table 5–3. Maximum Base-Plate and Rocking-Roller Reactions in Tons on Grillage at One Corner of Bridge

SS	Span in feet	30	40	50	60	70	80	90	100		
	Safe capacity	40	32	28	26	22	18	13	10		
	Caution capacity	55	45	38	35	31	23	19	13		
	Base-plate reaction [1]	31	26	24	21.8	21	18	17	15		
	Rocking-roller reaction [2]	5.7	7.4	8.9	10.7	12.7	13.9	15.9	14.4		
DS	Span in feet	50	60	70	80	90	100	110	120	130	140
	Safe capacity	80	67	64	51	44	31	23	18	13	10
	Caution capacity	100	84	80	64	55	40	34	23	19	13
	Base-plate reaction [1]	56	48	45	39	35	30	27	23	22	20
	Rocking-roller reaction [2]	10.5	12.8	14.5	16.8	18.8	20.5	22.8	24.9	26.8	23.9
TS	Span in feet	80	90	100	110	120	130	140	150	160	
	Safe capacity	80	62	52	40	34	23	18	13	10	
	Caution capacity	100	78	65	50	43	32	23	19	13	
	Base-plate reaction [1]	59	50	43.5	38	34.5	31	27	26	25	
	Rocking-roller reaction [2]	19.0	21.5	23.5	26.0	28.0	30.5	33.0	30.5	29.8	
DD	Span in feet	100	110	120	130	140	150	160	170	180	
	Safe capacity	75	64	50	40	31	23	19	13	10	
	Caution capacity	94	80	63	51	44	32	29	19	13	
	Base-plate reaction [1]	60	53	47	42	39	35	35	32	30	
	Rocking-roller reaction [2]	26.8	29.8	32.0	34.8	38.3	41.0	38.0	40.8	38.3	
TD	Span in feet	110	120	130	140	150	160	170	180	190	
	Safe capacity	80	70	57	48	40	31	23	18	12	
	Caution capacity	100	88	75	61	50	43	31	23	16	
	Base-plate reaction [1]	68	62	57	53	49	48	44	42	40	
	Rocking-roller reaction [2]	35.8	39.3	43.3	46.8	50.3	51.0	49.3	47.0	46.0	
DT	Span in feet	130	140	150	160	170	180	190	200	210	
	Safe capacity	80	67	65	56	50	40	31	23	18	
	Caution capacity	100	87	81	70	63	50	44	31	23	
	Base-plate reaction [1]	73	67	55	64	63	60	58	54	51	
	Rocking-roller reaction [2]	47.5	50.8	54.8	59.0	59.8	59.5	56.8	55.5	56.3	
TT	Span in feet	170	180	190	200	210					
	Safe capacity	70	57	50	40	29					
	Caution capacity	88	75	64	50	36					
	Base-plate reaction [1]	85	82	78	75	69					
	Rocking-roller reaction [2]	60	60	60	60	60					

[1] Includes weight of footwalks, ramps, bearings, and base plate. Live load assumed to be caution load on center line of bridge.
[2] Includes weight of rocking rollers, bearings, and template. Bridge launched without footwalks.

0.5	7 / 3	11 / 8	11 / 10	13 / 9	22 / 22	41 / 30	30 / 17	87 / 60	43 / 31
1.0	13 / 6	22 / 16	22 / 20	26 / 19	45 / 45	46 / 39	59 / 34	90 / 60	86 / 60
2.0	27 / 12	45 / 31	45 / 40	51 / 37	71 / 57	63 / 45	75 / 34	90 / 60	99 / 60
2.5	34 / 15	56 / 39	56 / 51	61 / 46	71 / 57	79 / 57	75 / 34	90 / 60	99 / 60
3.5	47 / 21	79 / 45	79 / 60	61 / 60	71 / 57	99 / 60	75 / 34	90 / 60	99 / 60
		Material required							
		Supplied in panel bridge set					Not in panel bridge set		
	No grillage required	17 pcs 6″ x 6″ x 4′6″	27 pcs 6″ x 6″ x 4′6″ 9 pcs 3″ x 6″ x 4′6″	2 ramps 20 pcs 6″ x 6″ x 4′6″	4 ramps 47 pcs 6″ x 6″ x 4′6″	3 ramps 28 chess	3 pcs 8″ x 8″ x 6′0″ 5 pcs 8″ x 8″ x 8′0″ 12 pcs 8″ x 8″ x 12′0″	4 transoms 10 pcs 2″ x 6″ x 4′6″ 4 pcs 6″ x 6″ x 4′6″ 30 pcs 8″ x 8″ x 12′0″	3 ramps 15 pcs 8″ x 8″ x 15′0″

Upper figure represents the maximum safe load on the base plate. Lower figure gives maximum allowable load on each rocking roller template.

Detailed analysis: (1) From table 5–3, corner reactions are 59 tons—base plate, 19.0 tons—rocking rollers.

(2) From table 5–4, type 4 and type 5 grillage provide the necessary capacities. Type 4 provides 71 tons base plate and 57 tons rocking roller. Type 5 provides 63 tons base plate and 45 tons rocking roller. Either of these could be used depending upon availability of materials.

(5) *Banks of different capacities.* Although it is unlikely, if the near bank has a different soil bearing capacity than the far bank, the grillage must be determined separately for each bank.

(6) *Slope check.* The maximum allowable slope for a Bailey bridge is 1:30. If bank heights differ enough to cause a greater slope, the low end may be cribbed up to decrease the slope. The cribbing must have at least the same bearing area as the required grillage. If cribbing is impractical, the high end may be excavated to reduce the slope.

(7) *Grillage configurations.* Figures 5–10—5–17 show the dimensions of and necessary materials for the grillage types.

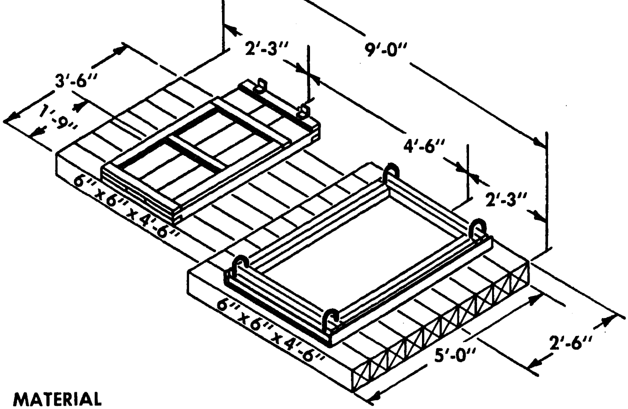
Note Types 6, 7, and 8 are made from materials not issued with the bridge set.

5–5. Determination of Final Bridge Length

If grillage is required, the roller clearance is increased. This may affect the required bridge length. If so, the truss and grillage type must be rechecked for the new bridge length. The required roller clearances for each type of grillage are shown in figures 5–10 through 5–17.

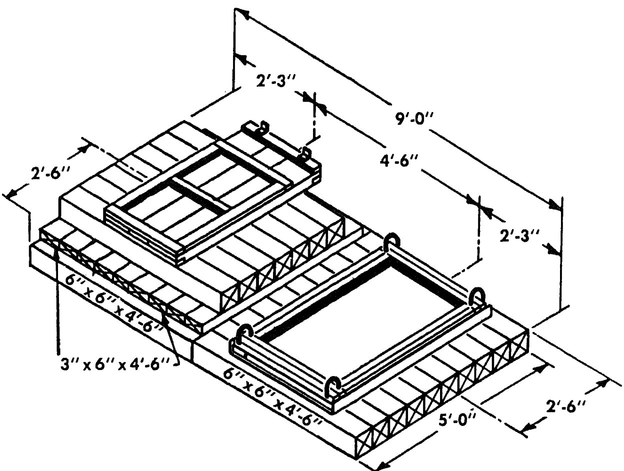
Table 5-5. Types of Grillage Needed

Construction	Safe soil pressure (tons per sq. ft.)	30′	40′	50′	60′	70′	80′	90′	100′	110′	120′	130′	140′	150′	160′	170′	180′	190′	200′	210′
SS	0.5	5, 7, 8	5, 6, 7, 8	5, 6, 7, 8	4	4	4	4	4											
	1.0	4	3	3	1	1	1	1	1											
	2.0	1	None	None	None	None	1	1	1											
	2.5	None	None	None	None	None	None	None	None.											
	3.5	None	None	None	None	None	None	None	None.											
DS	0.5			7	7	7, 8	5, 7, 8	5, 7, 8	5, 7, 8	5, 7, 8	5, 7, 8	5, 7, 8	5, 7, 8							
	1.0			5, 7, 8	6, 7, 8	4	4	4	4	4	4	4	4							
	2.0			4	3	1	1	1	1	1	1	1	1							
	2.5			1	1	1	1	1	1	1	1	1	1							
	3.5			1	None	None	None	None	None	1	1	1	1							
TS	0.5						7	7	7, 8	5, 7, 8	5, 7, 8	5, 7, 8	7	7, 8	5, 7, 8					
	1.0						5, 7, 8	6, 7, 8	4	4	4	4	4	4	4					
	2.0						4	3	1	1	1	1	2	1	1					
	2.5						3	1	1	1	1	1	1	1	1					
	3.5						1	1	1	1	1	1	1	1	1					
DD	0.5								7	7	7	7	7	7	7	7	7			
	1.0								7, 8	6, 7, 8	6, 7, 8	4	4, 5, 7, 8	4, 7, 8	4, 5, 7, 8	4, 7, 8	4, 5, 7, 8			
	2.0								4	4	3	2	2	4, 5, 7, 8	2	4, 5, 7, 8	2			
	2.5								3	1	1	1	1	2	1	2	1			
	3.5								1	1	1	1	1	1	1	1	1			
TD	0.5									7	7	7	7	7	7	7	7	7		
	1.0									7, 8	7, 8	7, 8	7, 8	7, 8	7. 8	7, 8	7, 8	7, 8		
	2 0									4, 7, 8	4, 5, 7, 8	4, 5, 7	4, 7, 8	4, 7, 8	4, 7, 8	4, 7, 8	4, 7, 8	4, 7, 8		
	2.5									4, 5, 7, 8	3	2	2	2	2	2	2	2		
	3.5									1	1	1	2	2	2	2	2	2		
DT	0.5											7		7	7	7	7	7	7	7
	1.0											7, 8	7, 8	7, 8	7, 8	7, 8	7, 8	7, 8	7, 8	7, 8
	2.0											7, 8	4, 7, 8	4, 7, 8	7, 8	7, 8	7, 8	4, 7, 8	4, 7, 8	4, 7, 8
	2.5											5, 7, 8	4, 5, 7, 8	4. 5, 7, 8	7, 8	7, 8	7, 8,,	4, 5, 7, 8	4, 5, 7, 8	4, 5, 7, 8
	3.5											2	2	2	2	2	2	2	2	2
TT	0.5															7	7	7	7	7
	1.0															7, 8	7, 8	7, 8	7, 8	7, 8
	2.0															7, 8	7, 8	7, 8	7, 8	4, 7, 8
	2.5															7, 8	7, 8	5, 7, 8	5, 7, 8	4, 5, 7, 8
	3.5															5, 7, 8	5, 7, 8	2	2	2



MATERIAL
17 PCS 6"x6"x4'-6"

Figure 5–10. Type 1 grillage.



MATERIAL
27 PCS 6"x6"x4'-6"
9 PCS 3"x6"x4'-6"

Figure 5–11. Type 2 grillage.

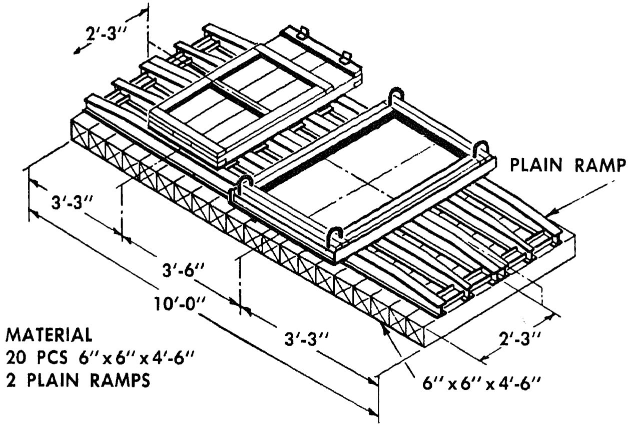


Figure 5–12. Type 3 grillage.

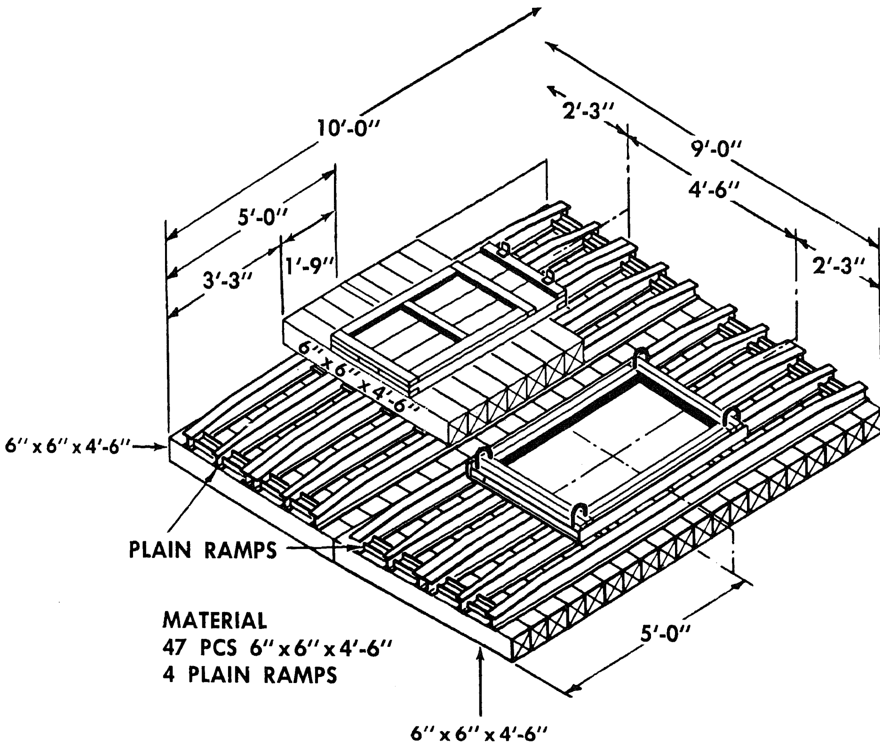


Figure 5–13. Type 4 grillage.

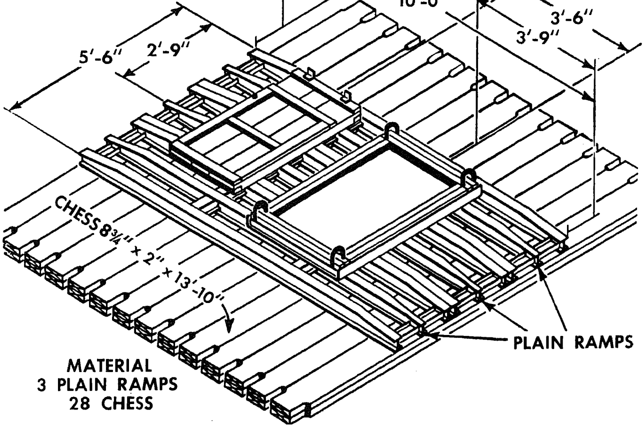


Figure 5–14. Type 5 grillage.

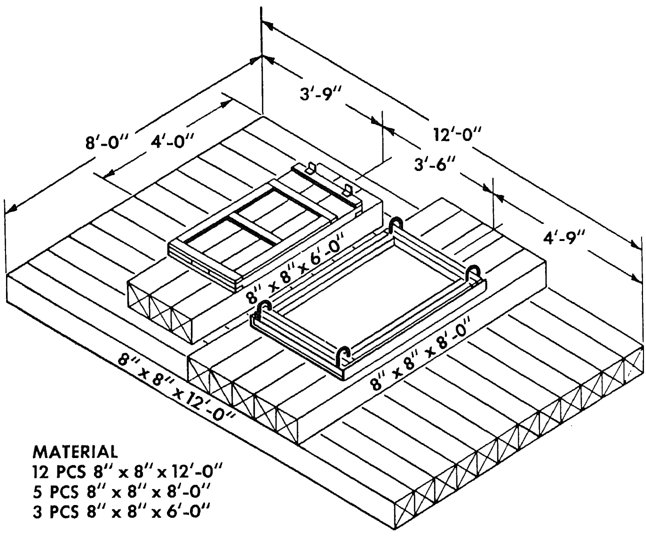


Figure 5–15. Type 6 grillage.

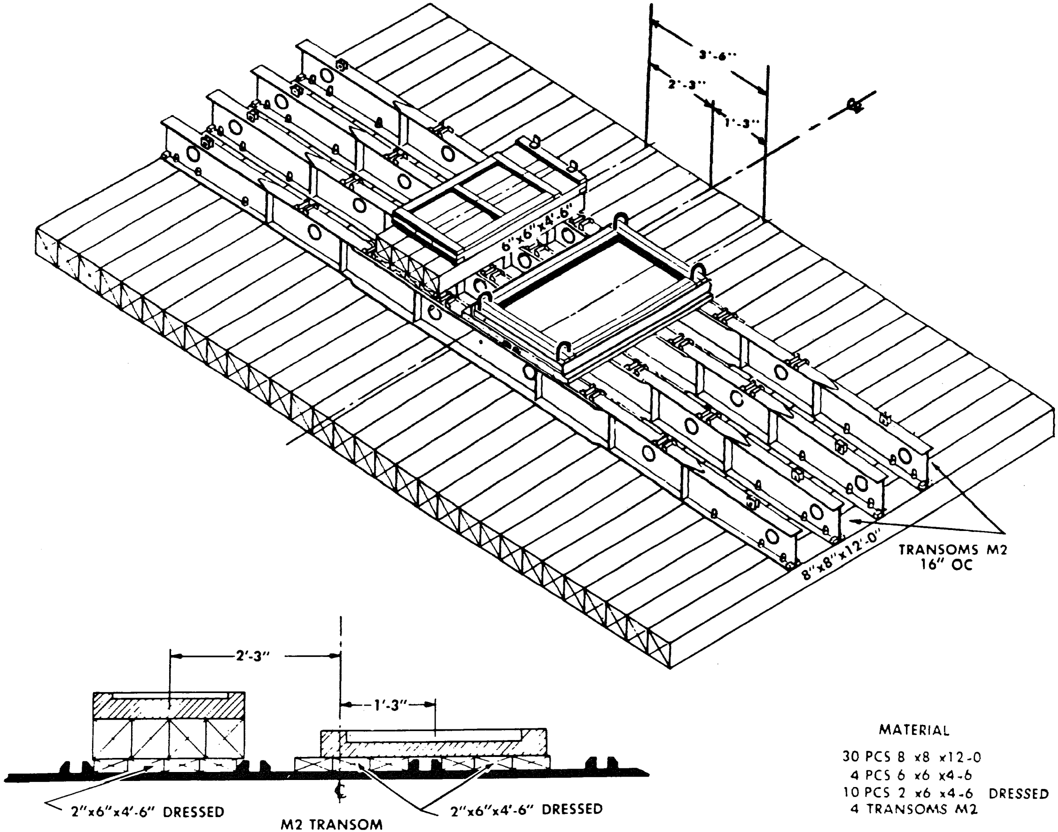


Figure 5–16. Type 7 grillage.

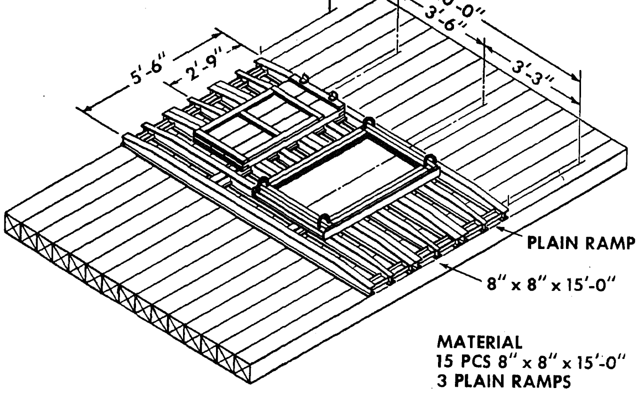


Figure 5–17. Type 8 grillage.

Example:

Given: Initial bridge length—78.5 or 80′
Required class 50/55
Initial truss type—double-single
Soil bearing capacity—2 tons/square foot

Required: Determine the final bridge length, truss, and grillage type.

Solution: (1) From table 5–5, grillage required—type 1.
(2) Roller clearance from figure 5–10—4′6″.
(3) Initial roller clearance was 2′6″ therefore 2 more feet must be added to each end of bridge:
New bridge length = 78.5′ + 2′ + 2′
= 82.5 or 90′
(4) Recheck truss type, table 5–1. 90′ triple-single required.
(5) Recheck grillage, table 5–5 type 3 required.
(6) Recheck roller clearance, figure 5–12. 3′6″. This will not increase the bridge length.
(7) Final—90′ TS, type 3 grillage.

Section II. LAUNCHING NOSE

5–6. General

The panel bridge is normally launched by cantilevering a skeleton framework, called the launching nose, over the gap. The weight of the bridge acts as the counterweight. When the launching nose reaches the far shore, it rests on the rocking rollers and supports the bridge as it is pushed across the gap. The composition of the nose depends on the length of the bridge and the type of assembly. The composition of the launching nose for the various combinations of span and bridge assembly is given in chapter 7, tables 7–1, 7–2, and 7–3; chapter 8, tables 8–1 and 8–2; and chapter 9, tables 9–1 and 9–2. These tables must be followed exactly with respect to the composition of the launching nose.

5–7. Use of Launching-Nose Links

a. Purpose. The launching nose tends to sag as it is cantilevered over the gap. The approximate sag at the end of the nose just before it reaches the far bank is shown in the above-mentioned tables. To overcome this sag, launching-nose links are used (fig 2–36 and 5–18). Using one launching-nose link in each truss increases the length of the bottom chords of the launching nose by 7½ inches; thus, the end of the launching nose is raised by 13½ inches for each bay ahead of the

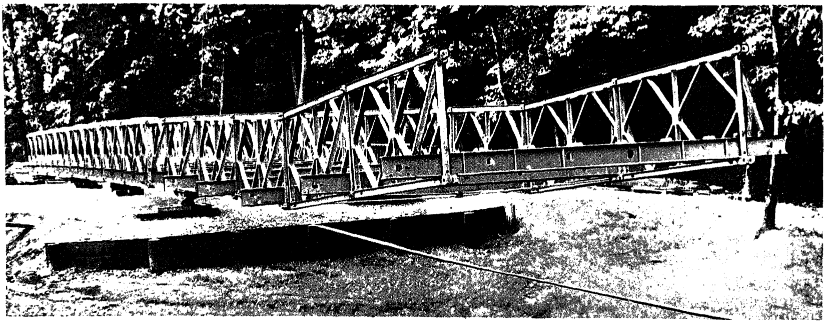


Figure 5–18. Upturned skeleton launching nose.

links. Because links must not be inserted with more than four bays of the launching nose ahead of them, the maximum amount of lift that can be obtained from one pair of links is about 54 inches. If a greater amount of lift is required, an additional pair of links can be used in one of the joints between the original pair and the end of the nose, its place depending on how much lift is required. Table 5–6 gives the vertical lifts that can be obtained using one or more pairs of links. The maximum lift obtainable using launching-nose links is 94½ inches. When calculating the position of the links, add an additional 6 inches to sag values shown for safety.

b. *Far-Bank Seat Higher Than or Level With Near Bank Seat.* When the far-bank seat is higher than or level with the near-bank seat, launching-nose links must be used to compensate for sag, and the tops of all rollers must be in the same plane. If necessary, block and tackle should be used to prevent the bridge from sliding backwards.

c. *Far-Bank Seat Lower Than Near-Bank Seat.* Launching-nose links are necessary if the far-bank seat is low enough to require the use of block and tackle on the near bank to prevent the bridge from running away when the balance point passes the rocking rollers.

d. *Example of the Use of Launching-Nose Links.*

Given—

A 160-foot TS bridge with approximate sag of 77 inches at the tip of the launching nose (table 7–3). The far-bank seat is level with the near-bank seat.

Problem—

Are launching nose links required? If links are required what distance are they placed from tip of launching nose?

Solution—

Launching-nose links are required (*b* above). The sag at the tip of the launching nose is 77 inches, and 6 inches is added for safety. From table 5–6 it is found that for a sag of 83 inches, it is necessary to use a pair of links at 30 feet and another pair at 40 feet from the tip of the launching nose.

Table 5–6. Use of Launching-Nose Links

Distance of links from tip of launching nose (feet)	Resulting vertical lift of tip of nose (inches)
One pair of links:	
10	13½
20	27
30	40½
40	54
Two pairs:	
10 and 40	67½
20 and 40	81
30 and 40	94½

e. ***Field Method.*** Table 2–1 gives the number and position of launching nose links required for normal bridges. This table assumes that both near and far shore rocking rollers are at the same elevation.

To complete the field design of a Bailey bridge, the number of rollers and jacks required must be determined. Chapter 6 provides details on placing the rollers.

5–9. Rocking Rollers

Rocking rollers are used on both banks during launching. Normally two rocking rollers are used on the near bank for single-single and double-single truss types of 100 feet and shorter and four are used for all other assemblies. Two rocking rollers are normally required on the far bank; however, four are used if the skeleton launching nose is double-truss in any part. Table 5–7 shows the required number of rocking rollers on near and far banks for various bridge lengths and assemblies.

Table 5–7. Number of Rocking Rollers Needed for Bridge

Type	Span (ft)	Near bank	Far bank
SS	30–100	2	2
DS	50–80	2	2
	90–100	2	2
	110–140	4	2
TS	80–160	4	2
DD	100–130	4	2
	140–180	4	4
TD	110–120	4	2
	130–190	4	4
DT	130–210	4	4
TT	160–210	4	4

5–10. Plain Rollers

Rows of plain rollers are placed behind the rocking rollers at intervals of 25 feet to support the bridge during construction. The number of rollers in each row depends on the type of bridge. Single-single and double-single bridges need two plain rollers per row. All other types of construction need four plain rollers per row (chap 6). The number of rows required depends on the construction backspace needed (table 2–1). Plain rollers need only be placed every 25 feet. Additional rollers are not required to support an overhang under 25 feet. In addition, two construction rollers are used to aid in inserting the launching-nose links. rocking rollers and 2 to 4 inches below the plane of the other rollers. These may be removed once the construction extends back to the first row of plain rollers. The number of plain rollers needed for various bridges is shown in table 5–8. Also see table 2–1.

Table 5–8. Rows of Plain Rollers Required

Bridge length (ft)	Truss type						
	SS	DS	TS	DD	TD	DT	TT
30–50	1	1					
60–80	2	2	2				
90	3	2	2				
100	3	3	2	2			
110–120		3	3	3	3		
130		3	3	3	3	3	
140		3	4	4	3	3	
150			4	4	4	4	
160			4	4	4	4	3
170				4	4	4	3
180				4	5	4	4
190					5	5	4
200–210						5	4

Table 5–9. Number of Jacks Needed at Each End of Bridge

Truss type	Span (ft)	No. of jacks needed at each end of bridge
SS	30–100	2
DS	50–140	4
TS	80–140	4
	150–160	6
DD	100–120	4
	130–180	6
TD	110–140	6
	150–190	3
DT	130	6
	140–180	8
	190–210	10
TT	160–170	10
	180–210	12

Note. Jacks must be positioned so that they carry no more than 7½ tons on the toe or 15 tons on the top.

5–11. Jacks

The number of jacks required to jack down a bridge depends on the span length and the type of the bridge. The number of jacks needed to jack down each end of the bridge is shown in table 5–9. Details on jacking procedures are given in chapters 7, 8, and 9.

Section IV. RAMPS

5–12. Supports for Ramps

a. Support for End of Ramp. The end of the ramp will carry about one-quarter of the weight of the heaviest tracked vehicle to pass over it when the ramp is supported at midspan. If there is no midspan support, the end of the ramp will carry about four-tenths of the weight of the tracked vehicle. One or two stacks of chess side-by-side are laid in two layers under the tapered end of the ramp to provide the necessary bearing area on the soil. If greater area is needed for heavy loads on very soft soil, footings are used under the chess. On soil capable of supporting 2 tons per square foot, two chess under the tapered end of the ramp are enough for bridges up to class 67. For higher capacity bridges, four chess are used (fig 5–19). One chess on edge at the end of the ramp serves as an end dam so the approach can be made level with the ramp floor.

b. Midspan Ramp Supports.

(1) For loads of 45 tons or over, each ramp section must be supported at its midpoint by cribbing and wedges (fig 5–20). This support will carry one-half of the class of the vehicle passing over, and the area of the base of the cribbing should be large enough to spread the load over the soil without exceeding the allowable bearing pressure of the soil. On soil capable of supporting 2 tons per square foot, two chess side-by-side under the cribbing provide enough bearing area for all bridges.

(2) An alternate method for loads of 45 tons or over is to make the ramp level with at least 3½ feet of the ramp supported on the abutment (fig 5–21).

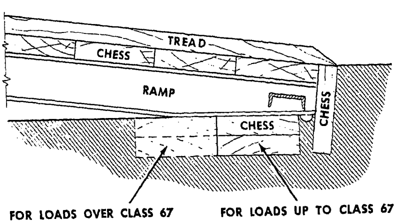


Figure 5–19. Support for end of ramp.

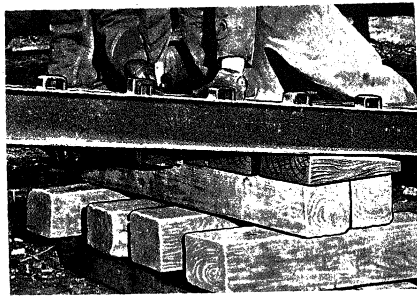


Figure 5–20. Cribbing and wedging under ramp at midpoint to carry loads of 45 tons or over.

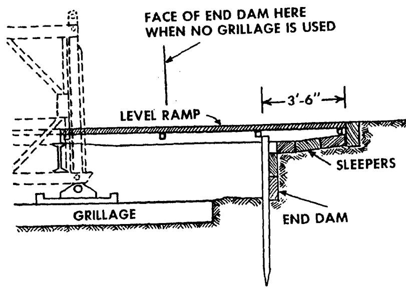


Figure 5–21. Level 10-foot ramp for loads of 45 tons or over.

c. Pedestal Supports. Because the slope of t ramp should not exceed 10 to 1, it may be nec sary to use two ramp bays. The junction of t two ramp bays rests on a transom supported four ramp pedestals spaced as shown in figu 5–22. These pedestals take two-thirds of the cl of the vehicles passing over and must be set enough grillage to spread the load over the s Three 6- by 6-inch timbers 4 feet 6 inches lo under each pair of pedestals provide enough a for 40-ton loads on soil that will carry 2 tons square foot. For heavier loads, three chess placed side-by-side under the 6- by 6-inch timb

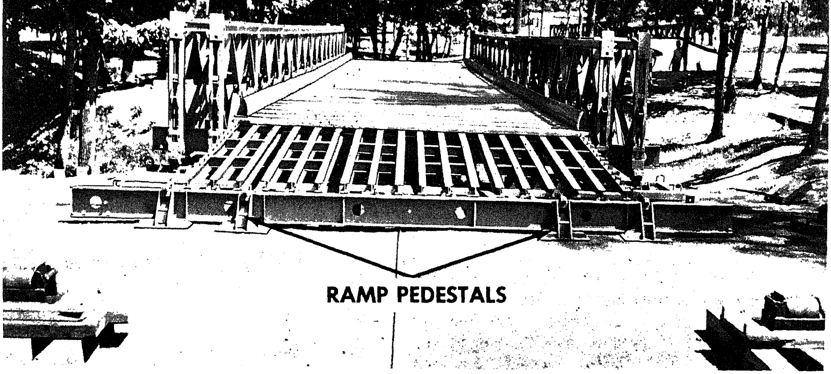


Figure 5–22. Ramp pedestals in place in two-bay ramp.

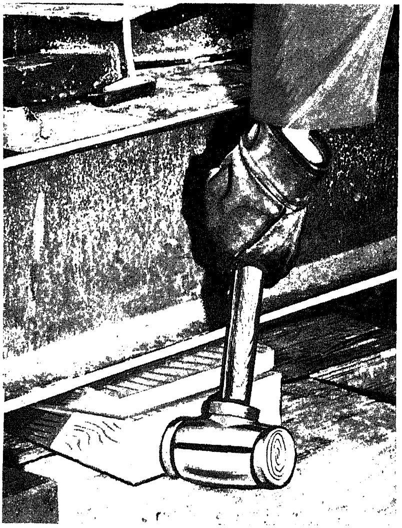


Figure 5–23. Cribbing and wedging under center of end transom to carry loads of 40 tons or over.

5–13. Supports for End Transom

For loads of 40 tons or more, cribbing and wedges are used under the midpoint of the end transom (fig 5–23). This support will carry four-tenths of the weight of the heaviest tracked vehicle to pass over, and the area of the base of the cribbing should be large enough to spread the load over the ground without exceeding the allowable bearing pressure on the soil. Seven 6- by 6-inch timbers 4 feet 6 inches long laid side-by-side provide enough area for all the bridge loads on soil that will carry 2 tons per square foot.

Section V. EXAMPLE FIELD DESIGN PROBLEM

5–14. Bailey Bridge Example Problem (fig. 5–24)

Given: Gap—112′
Abutments—Far shore prepared, near shore unprepared.
Bank height—Near shore: 18′
Far shore: 20′
Vehicle class—60 wheel and track
Soil—Near shore—loose fine sand
Far shore—compact sand

Required: Determine the final bridge length, truss and grillage type, launching nose, number of rollers and jacks, and cribbing to obtain required class.

5–15. Solution of Problem

a. Bridge Length, Truss and Grillage Type.

(1) Initial bridge length
L = 112′ + [3.5′ + 1.5(18′)] + 2.5 + 2.5
= 147.5′ Round up to 150′

(2) Truss type
Double-triple from table 5–1.

(3) Grillage

(*a*) Near shore

1. Soil bearing capacity from table 5–2
SBC = 2 tons/sq foot

2. Grillage type from table 5–5
Types 4, 7, or 8
However, types 7 and 8 require materials not issued with bridge set, therefore use type 4.

(*b*) Far shore

1. Soil bearing capacity from table 5–2
SBC = 6 tons/sq ft

2. Grillage type from table 5–5
None required

(4) Recheck bridge length

(*a*) Required roller clearances (using type 4 grillage)

1. Near shore—4′6″ (fig 5–14)

2. Far shore—2′6″

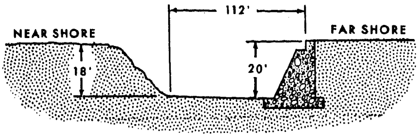


Figure 5–24. Profile of bridge site—example problem.

(*b*) L = 112′ + 3.5′ + 1.5(18′) + 2.5 + 4.5
L = 149.5′ Round up to 150′

(5) Slope check

(*a*) Bank height difference 2′

(*b*) Grillage height—Timber 6″ (fig. 5–13)
Ramps 5″ (para 2–20)

(*c*) Total height difference 2′11″

(*d*) Slope = 2′11″/150′ *N* 1:50 OK
Answer a: 150′DT, type 4 grillage

b. Launching Nose.

(1) Length and composition of nose (table 9–1)
90′: 5 bays SS, 4 bays DS

(2) Links

(*a*) Required lift

1. Sag = 34 inches (table 9–1)

2. Bank height = + 24″ (given)

3. Safety = 6″

4. Grillage = 17″ (fig 5–13)
Total lift = 34″ + 24″ + 6″ − 17″ = 47″

(*b*) Number and placement of links—table 5–6

1. One pair

2. 40 feet

c. Rollers and Jacks.

(1) Rocking rollers (table 5–7)
Near shore—4
Far shore—4

(2) Plain rollers

(*a*) Rollers per row
4 per row—(para 5–10)

(*b*) Number of rows
4—(table 5–8)

(*c*) Construction rollers
2

(*d*) Total plain rollers
16 + 2 construction = 18

(3) Number of jacks at each end
8—(table 5–9)

d. Cribbing.

(1) End of ramp
One stack of chess, two layers deep under end of ramp (para 5–12*a*)

(2) Midspan ramp supports
Crib under midspan of ramp (para 5–12*b*)

(3) Ramp pedestal supports

Crib under pedestals with 3 chess under 6" X 6" timbers on near shore. Far shore requires none (para 5–12).

(4) Support for end transoms
Crib under center of end transoms (para 5–13).

Section VI. BRIDGE CLASSIFICATION

5–16. Classification of Existing Bridges

a. Bailey bridge classifications may be determined by entering table 5–1 with the span length and truss type. This will give the classification of the bridge for normal, caution, and risk crossings. Table 5–10 gives restrictions for the types of crossings.

Table 5–10. Bailey Bridge Crossing Restrictions

	Traffic restrictions		
	Normal	Caution	Risk
Vehicle Position	Any place on deck	On center line of deck	On center line of deck.
Max speed	25 mph	8 mph	3 mph.
Operation	No sudden stopping or accelerating.	No stopping, accelerating or gear shifting.	No stopping, accelerating or gearshifting. Tanks steer by clutch only.
Min spacing	30 yd tail to head convoy spacing.	50 yd tail to head	One vehicle on bridge at a time.
Authority to use	Anyone	Tactical area commander (normally corps or higher).	

Notes. 1. The caution class number is found by test and is normally 25 percent greater than the normal class.
2. Risk loads will very probably cause permanent deformation of bridge parts and may result in failure if repeated. Therefore, an engineer officer must thoroughly check the condition of the bridge before and after such a crossing.

b. The grillage, cribbing, and number of transoms per bay must also be checked and the bridge class reduced accordingly or upgraded to obtain the required classification.

c. The condition of the bridge and its supports must also be considered in its classification. If the bridge is deformed or damaged, the grillage has rotted, or the abutment has failed, the bridge classification must be drastically lowered (chap 22).

5–17. Example Classification

Given: Bridge length—80′
Truss type—DS
Grillage—none
Soil bearing capacity—10 tons/sq foot
Cribbing—none
Condition—excellent

Required: Determine the normal track classification of the bridge without upgrading.

Solution: 1. Class from table 5–1
55 track
2. Grillage—none required (table 5–5)
3. Cribbing
(*a*) Midspan ramp supports
None—limits class to 44 tons
(*b*) End transoms
None—limits class to 39 tons
4. Condition—Excellent, no reduction
5. Final classification—39 track

CHAPTER 6

ROLLER LAYOUT

6–1. Layout of Rollers

a. Rocking Rollers.

(1) *Longitudinal spacing.* The longitudinal location of the rocking rollers is established by the safety setback determined in the field design of the bridge (chap 5).

(2) *Lateral spacing.* A rocking roller (fig 6–1) is placed on each side of the bridge centerline, spaced 7 feet 5 inches out from it (fig 6–2). This gives a constant value of 14 feet 10 inches center to center between the rocking rollers. Most bridges are double or triple truss and need another set of rocking rollers (fig 6–3) placed 1 foot 6 inches out from each of the first set of rocking rollers (fig 6–4). Rocking roller templates have been produced which facilitate the proper 1 foot 6 inch center-to-center spacing of the rocking rollers. On the interior side of these templates, small angle iron lugs have been attached to facilitate roller spacing. The edge-to-edge spacing of the rocking roller templates (lug to lug) is 11 feet 6½ inches (fig 6–4). The lugs are, however, frequently lost through use and the most accurate method of spacing the rollers is to use the 14 foot 10 inch constant. The Bailey bridge transom is manufactured with a small hole in its center web and two dowel holes toward each end. These holes can be used to properly space the rocking rollers as shown in figures 6–5 and 6–6.

b. Plain Rollers.

(1) *Longitudinal spacing.* Two or more plain rollers are placed every 25 feet behind the rocking rollers to support the bridge during assembly and launching (fig 6–14). An extra set of plain rollers (called construction rollers) is temporarily placed 12½ feet behind the rocking rollers. The construc-

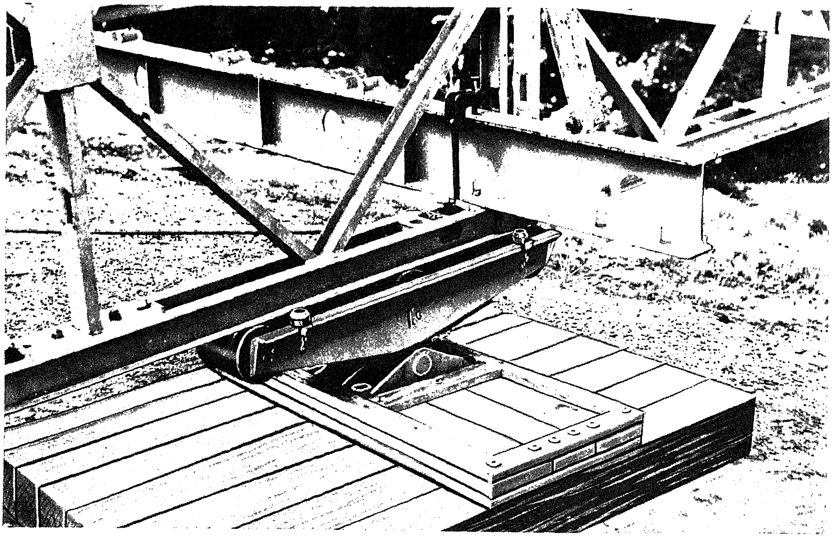


Figure 6–1. Truss on rocking roller.

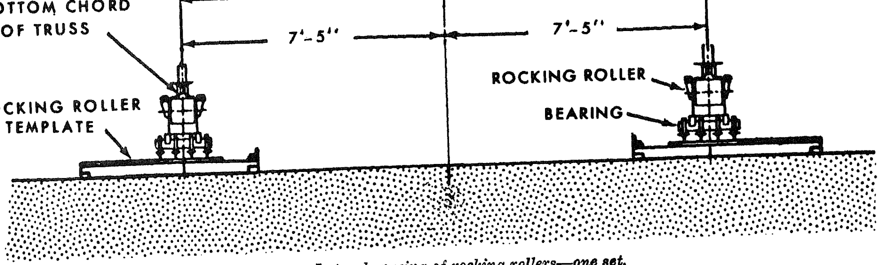


*Figure 6–2. Lateral spacing of rocking rollers—**one set.***

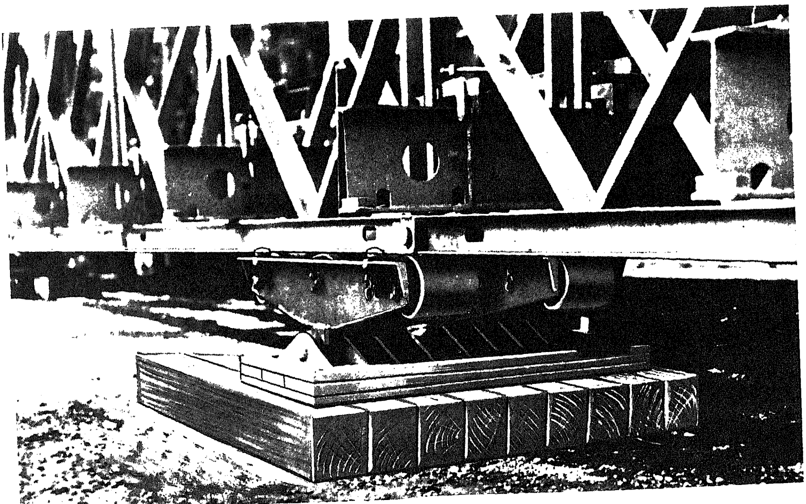


Figure 6–3. Two rocking rollers used on double-truss bridge.

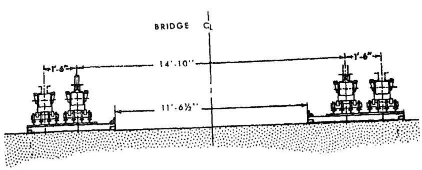


*Figure 6–4. Lateral spacing of rocking rollers—**two sets.***

tion rollers aid in inserting the launching-nose links and provide clearance between the links and the ground. These construction rollers are removed after the links have passed over the rocking rollers.

(2) *Lateral spacing.*

(*a*) For single-story, single- and double-truss bridges, two plain rollers are placed one on each side of the centerline every 25 feet. The center-to-center roller spacing is 14 feet 10 inches (7 feet 5 inches each side of the centerline). Plain rollers are normally placed on plain roller templates which increase the bearing area over the

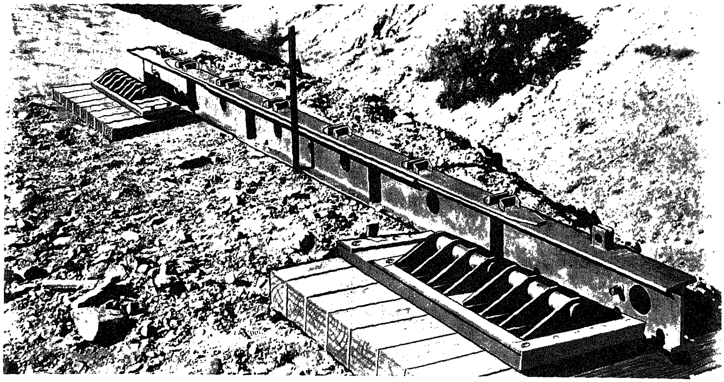


Figure 6-5. Lateral spacing of rocking rollers (using transom).

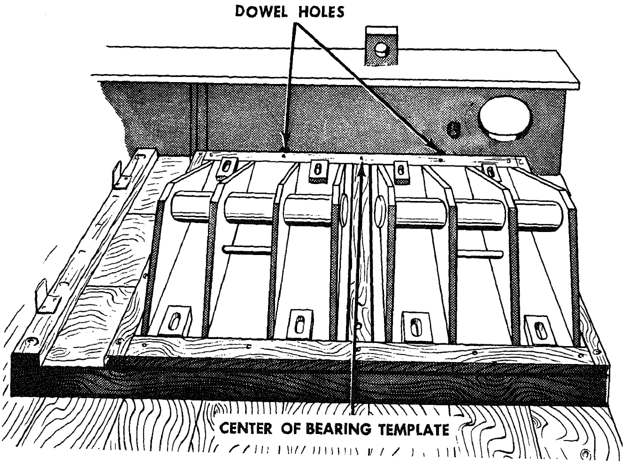


Figure 6-6. Use of transom to determine lateral spacing for rocking rollers or base plates.

ground. These templates also aid in the lateral spacing of the rollers. The templates are equipped with angle iron lugs like the rocking roller templates. The template is placed so the lugs face the centerline. The distance between lugs then is 11 feet 6½ inches (fig 6-7).

(*b*) For all other assembly types (TS, DD, TD, DT, TT) four plain rollers are used every 25 feet, two on each side of the centerline. Each plain roller consists of two small independent rollers. For triple truss or multistory bridges, the inside plain rollers are placed so that the inside truss will rest upon the second small roller (fig 6-8). The spacing between the centers of these small rollers, then, is 14 feet 10 inches. The other set of plain rollers is placed so that the second truss will rest on the first small rollers of this set (fig 6-8). The distance between these trusses is 1 foot 6 inches. The third truss will rest on the outermost small roller. Plain roller templates also

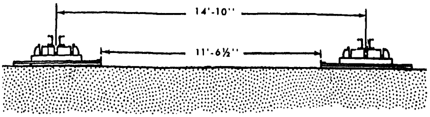


Figure 6–7. Lateral spacing of plain rollers for single-single and double-single Bailey bridges.

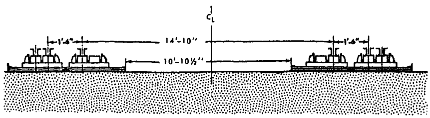


Figure 6–8. Lateral spacing of plain rollers for triple-truss and multistory Bailey bridges.

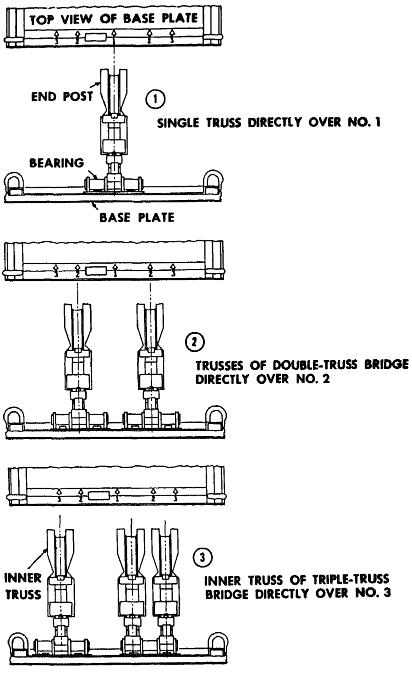


Figure 6–9. Use of base plate and bearings under single-, double-, and triple-truss bridges.

aid in lateral spacing of the plain rollers for the triple truss of multistory bridges. One template is used under each roller. Two templates are placed end to end on each side of the centerline with the angle iron lugs of the inside templates facing center and the outside lugs facing away from center. When the spacing between the inside lugs is 10 feet 10½ inches, the plain rollers will be at the proper spacing (fig 6–8).

6–2. Base Plates

a. Longitudinal Spacing. Longitudinal spacing between the center of the rocking rollers and the center of the base plate is established by the type of grillage required. The grillage type is determined as described in chapter 5.

b. Lateral Spacing.

(1) The base plates are placed under the trusses as shown in figure 6–9.

(2) Bearings are spaced on the base plates (under the trusses) as shown in figures 6–9 and 6–10.

6–3. Grillages

Figures 5–10 through 5–17 show the size of the areas to be leveled off to accommodate the grillages. Care must be taken that the rocking rollers and base plates are properly positioned when placed on the grillage. The grillage can be cribbed up or dug in as needed for leveling.

6–4. Elevation of Rollers and Base Plates

a. Base Plates. The base plates should be set at an elevation to keep the slope of the ramp bays less than 10 to 1. The height of the bridge floor above the grillage is shown in figure 6–11. Allowance for the depth of wear tread should also be considered.

b. Rollers. All rollers (both plain and rocking), except the construction rollers, are set so their tops are in the same horizontal plane. Normally, this plane is level, but a slight inclination not to exceed 30 to 1 slope along the line of the bridge is permissible. The construction rollers are set 2 to 4 inches below the level of the other rollers. Figures 6–12 and 6–13 show the height of the bottom panel chord above the grillages when plain and rocking rollers are used. Placing the far-bank rocking rollers a few inches lower than the plane formed by near-bank rollers allows for near-bank settlement caused by bridge weight.

6–5. Placement Control Lines

A simple method of leveling and placing rollers is the use of placement control lines. The bridge centerline is first placed and extended 25 feet on the

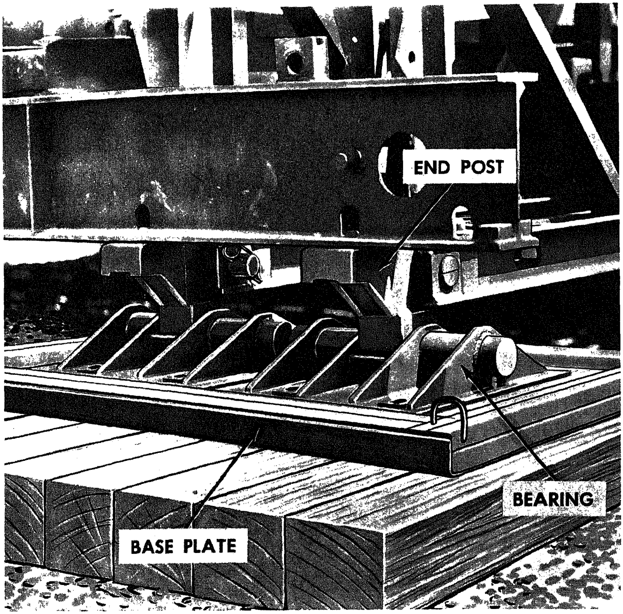


Figure 6–10. End posts resting on bearings in double-truss bridge.

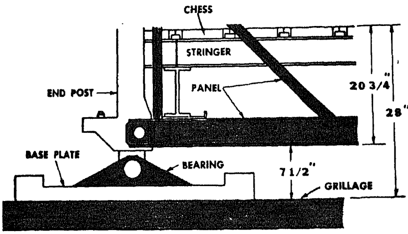


Figure 6–11. Height of bottom bridge chord above grillage, end post over bearing.

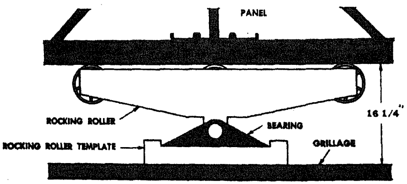


Figure 6–12. Height of bottom bridge chord above grillage, rocking roller.

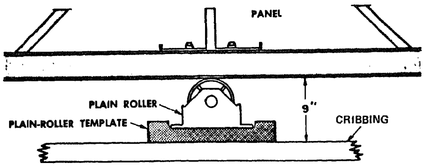


Figure 6–13. Height of bottom bridge chord above grillage, plain roller.

far shore and the length of the bridge and launching nose on the near shore. Two placement control lines are then placed parallel to and 7 feet 5 inches to either side of the centerline. The placement control lines are placed level with the proposed plane of the rollers. Line levels are used at several spots on the placement control lines to insure that they are level. It is also important to assure that the placement control lines are parallel to the centerline. The rollers can then be cribbed up or dug in as needed to bring their tops to the level of the placement control lines (fig 6–14).

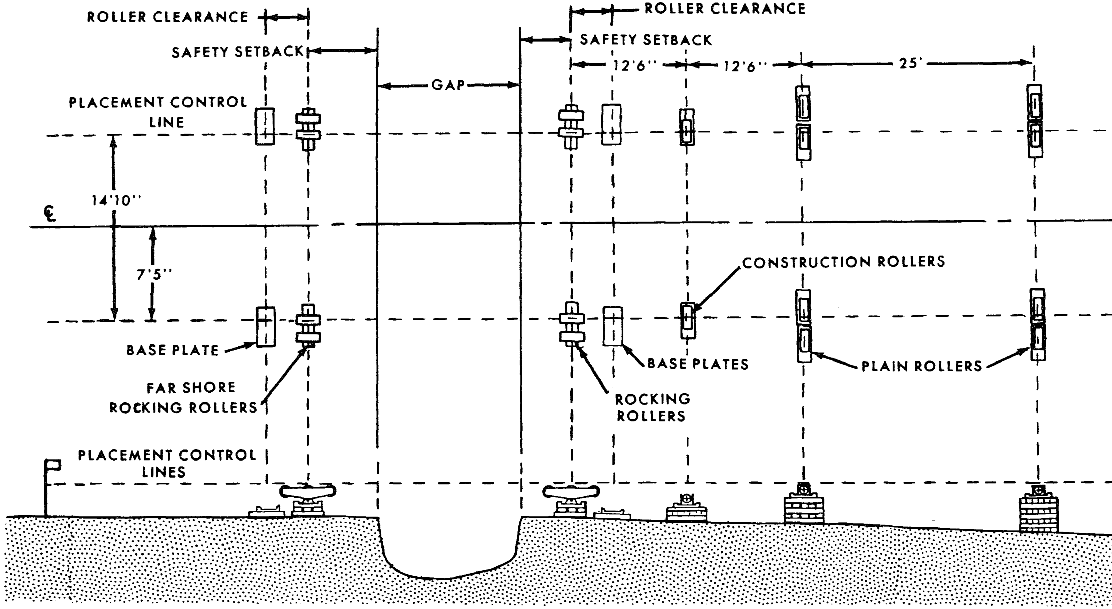


Figure 6–14. Plan and profile views of a typical roller layout for a triple-truss or multistory Bailey bridge.

CHAPTER 7

ASSEMBLY OF SINGLE-STORY BRIDGES

Section I. LAUNCHING NOSE

7–1. Description

The launching nose (fig 7–1) consists of panels, transoms, rakers, sway braces, and, when necessary, launching-nose links. It does not have stringers or decking. One transom with transom clamps and rakers is used behind the leading upright of each panel. Sway bracing is used in all but the first bay at the front of the launching nose. Footwalks are not assembled on the nose.

7–2. Assembly

The number and types of bays used in the nose depend on the length and truss type of the bridge. The composition of the launching nose for the various lengths of single-story bridge is given in tables 7–1 through 7–3. These tables must be followed exactly with respect to the composition of the launching nose.

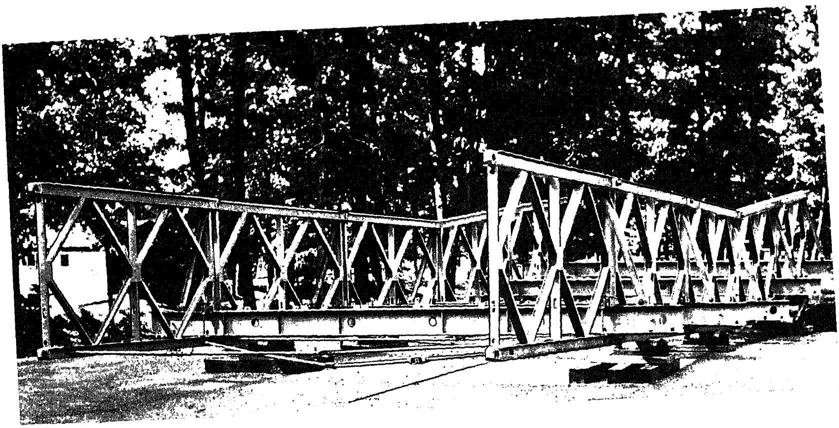
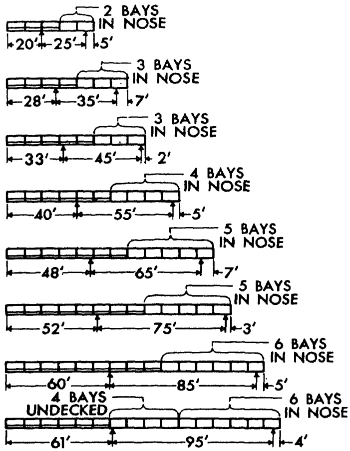


Figure 7–1. Launching nose.

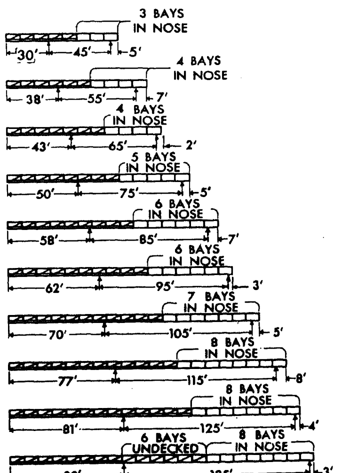
SPAN (FEET)	LAUNCHING WT (TONS)	SAG (INCHES)
30	11.0	3
40	14.5	4
50	17.5	5
60	21.0	8
70	25.0	12
80	27.5	15
90	31.5	25
100	28.5	33



SINGLE TRUSS WITH DECKING   SINGLE TRUSS

Table 7–1. Launching Nose Composition for Single-Single Bridges

SPAN (FEET)	LAUNCHING WT (TONS)	SAG (INCHES)
50	24	4
60	25.0	7
70	28.5	9
80	33.0	14
90	37.0	20
100	40.5	23
110	45.0	33
120	49.5	45
130	53.0	52
140	47.5	63



DOUBLE TRUSS WITH DECKING   DOUBLE TRUSS   SINGLE TRUSS

Table 7–2. Launching Nose Composition for Double-Single Bridges

SPAN (FEET)	LAUNCHING WT (TONS)	SAG (INCHES)
80	43.4	13
90	42.5	19
100	46.5	22
110	51.5	30
120	55.5	34
130	60.5	47
140	65.5	62
150	60.5	70
160	59.0	77

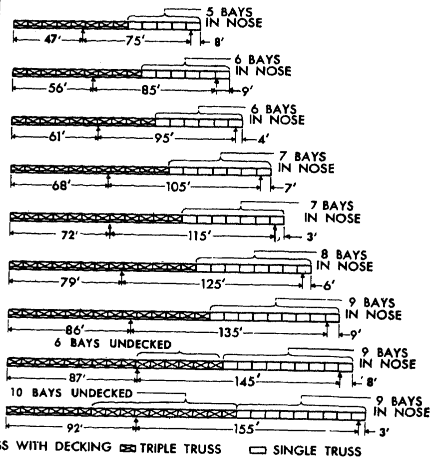


Table 7–3. Launching Nose Composition for Triple-Single Bridges

Section II. ASSEMBLY OF DOUBLE-SINGLE BRIDGE

7–3. Nose

After roller layout is complete, proceed with assembling and launching of nose as follows:

a. Place two panels (female end forward) on the ground just back of the rocking rollers. Clamp the transom to panel behind forward uprights. Secure rakers to transom and panel with bracing bolts. Raise rear of the first panel onto plain rollers (fig 7–2).

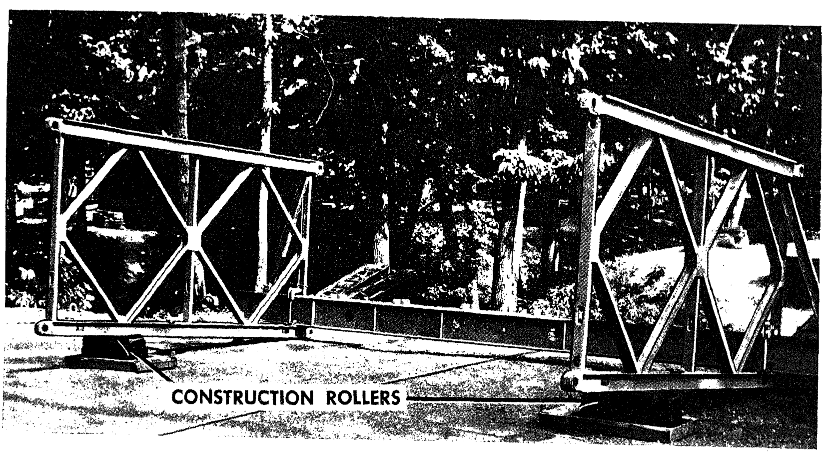


Figure 7–2. Launching nose, initial bay assembled.

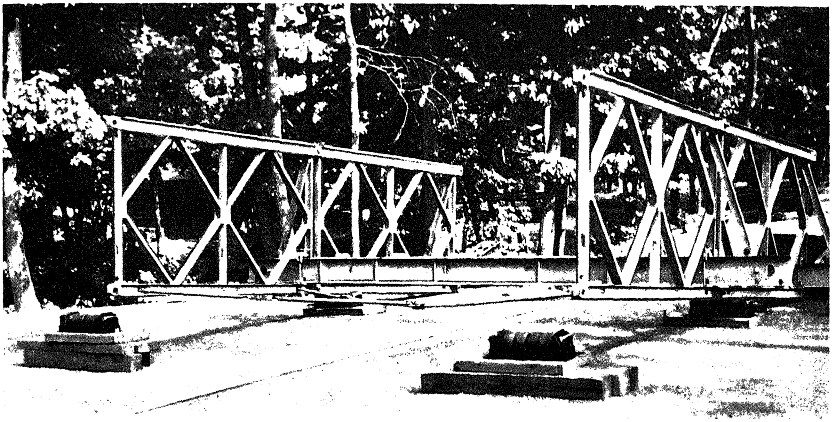


Figure 7–3. Launching nose, second bay connected to initial bay.

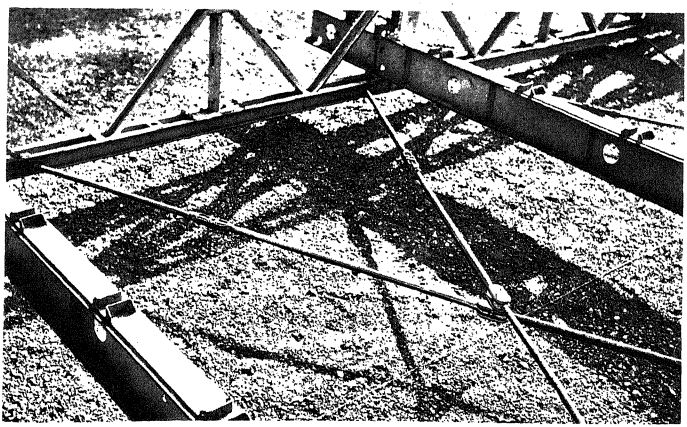


Figure 7–4. Sway braces in place in second bay of launching nose.

b. Connect second bay (fig 7–3). Insert panel pins (with points outward) and with grooves in the heads of pins horizontal (see inner truss of fig 7–13). Clamp transom to panels behind forward uprights.

c. Place pair of sway braces in second bay (fig 7–4).

d. Lift front end of assembled bays onto rocking rollers (fig 7–5) and secure with steel pickets through bottom chord of panels and rocking rollers (fig 7–6). An alternate method (for rocking rollers on low cribbing) is as follows: Assemble first bay on ground. Lift front end of bay onto rocking rollers (fig 7–7) and secure with steel pickets. Raise rear end and slide plain rollers under it 2 inches below plane of tops of rollers. This places plain rollers approximately 9 feet from rocking rollers. Add second bay.

e. If required, place launching-nose links in position between panels (fig 7–8) as determined by assembly conditions. See chapter 5 to determine the number of links and their position in the nose.

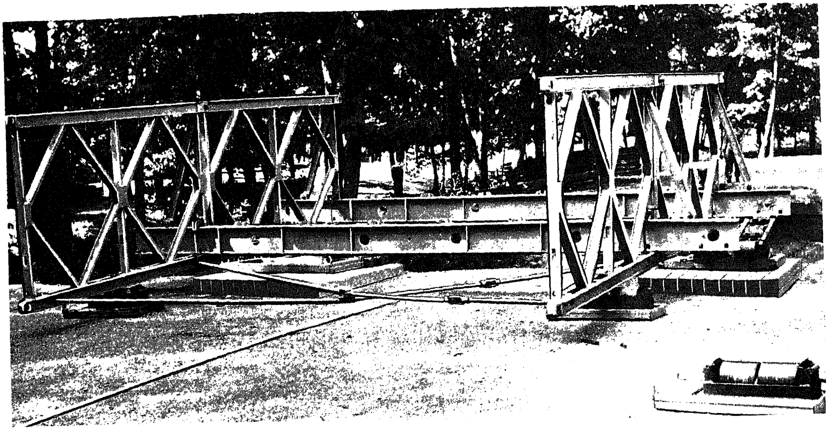


Figure 7–5. Launching nose, assembled bays mounted on rocking rollers.

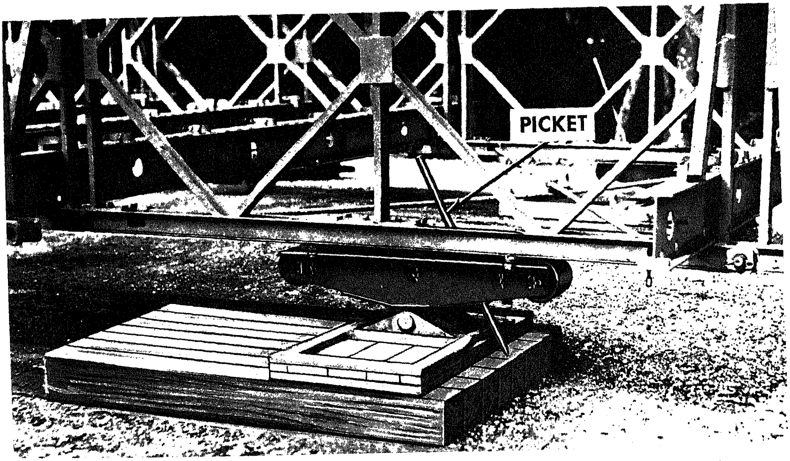


Figure 7–6. Front of launching nose with steel picket inserted in rollers to prevent movement.

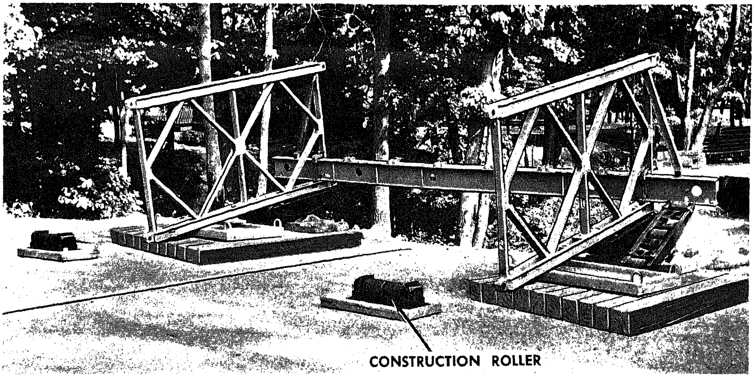


Figure 7–7. Alternate method for assembling launching nose when rocking rollers are on low cribbing.

Figure 7–8. Inserting panel pin to connect panel in launching nose to launching-nose links.

f. Continue adding panels with transoms every 10 feet, sway braces in every bay, and rakers on every transom, until the required amount of skeleton nose has been built.

7–4. First Bay of Bridge

When assembly of the nose is completed, assemble the first bay of the bridge as follows:

a. Connect first two panels of inner truss with last bay of nose (fig 7–9). Insert panel pins with points outward and grooves in heads of pins horizontal. Place transom roller on top of the lower panel chord at the transom location. The bottom angle lug of the roller is hooked over the near side of the top flange on the chord to hold the roller assembly in position. Lift the head of the transom onto the roller and shove it halfway across the bridge width, at which point two men should guide it to its seat on the panel chord. The near end of the transom is then raised sufficiently to permit removal of the roller. The first transom is placed in front of the middle vertical and clamped loosely with transom clamps. The transom roller is then moved to each succeeding transom point.

b. Add panels of outer truss in first bay and hold in place with transom clamps (fig 7–10).

c. Insert second transom in *front* of rear vertical and third transom *behind* front vertical. Clamp loosely. Fix rakers to second transom and panel (fig 7–11). Sway braces are positioned with

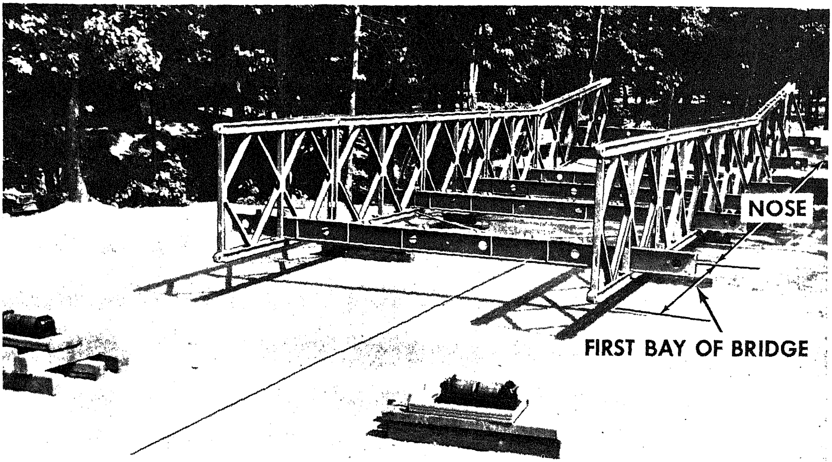


Figure 7–9. First bay, DS, assembly—single truss panels connected to launching nose.

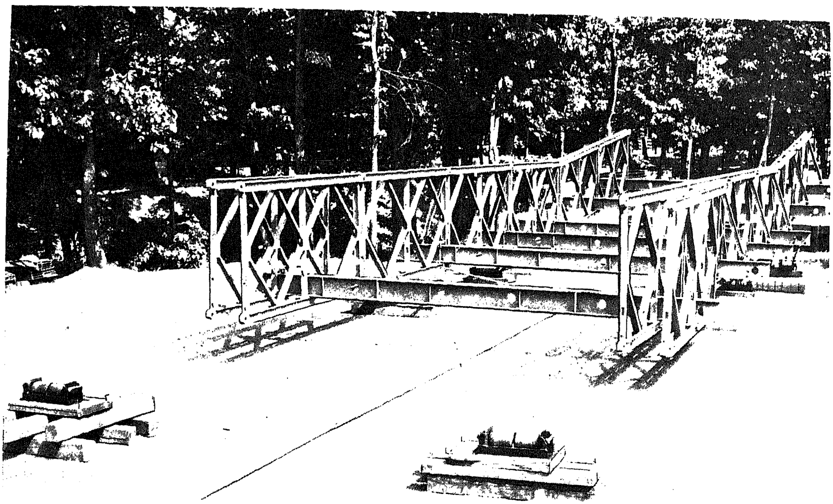


Figure 7–10. First bay, DS, assembly—outer truss panels added to first bay.

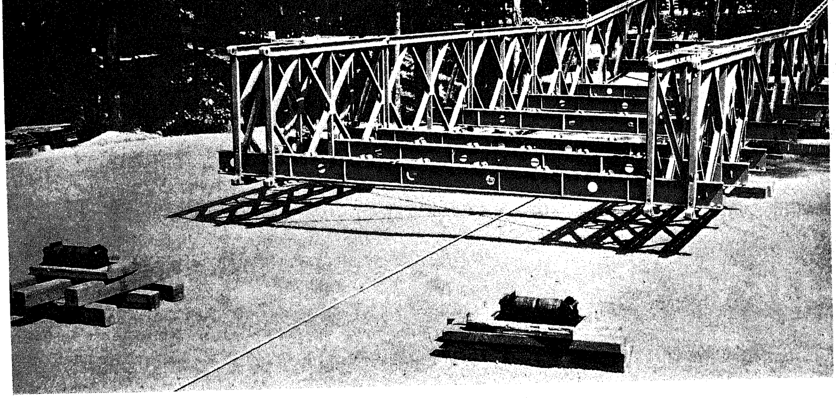


Figure 7–11. First bay, DS, assembly—second and third transoms and sway bracing added.

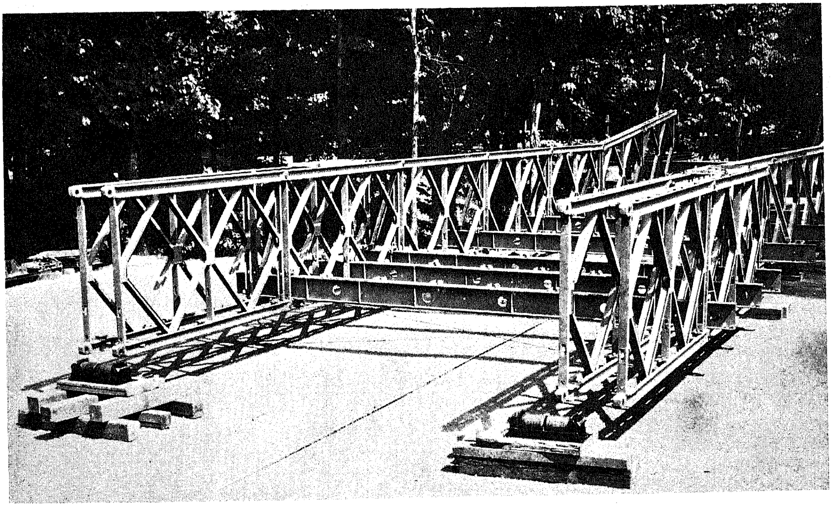


Figure 7–12. First bay, DS, assembly—second bay of panels added.

short ends pinned to same side of bridge so both turnbuckles are under one stringer. *All sway braces, transom clamps, bracing frames, rakers, and tie plates in one bay should be left loose until all parts except stringers and decking are fitted for the next bay being assembled.*

d. Add second bay of panels (fig 7–12). Place outer truss with panel pins pointing inward, and inner truss with panel pins pointing outward (fig 7–13).

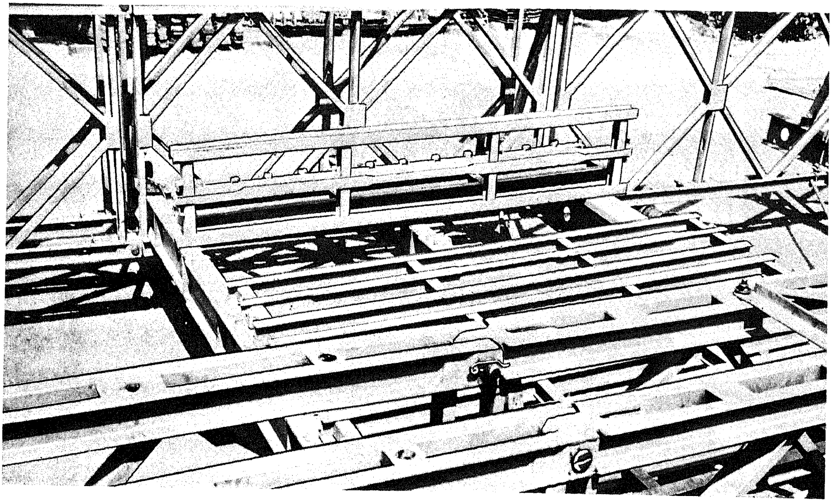


Figure 7–13. First bay, DS, assembly—stringers positioned in first bay.

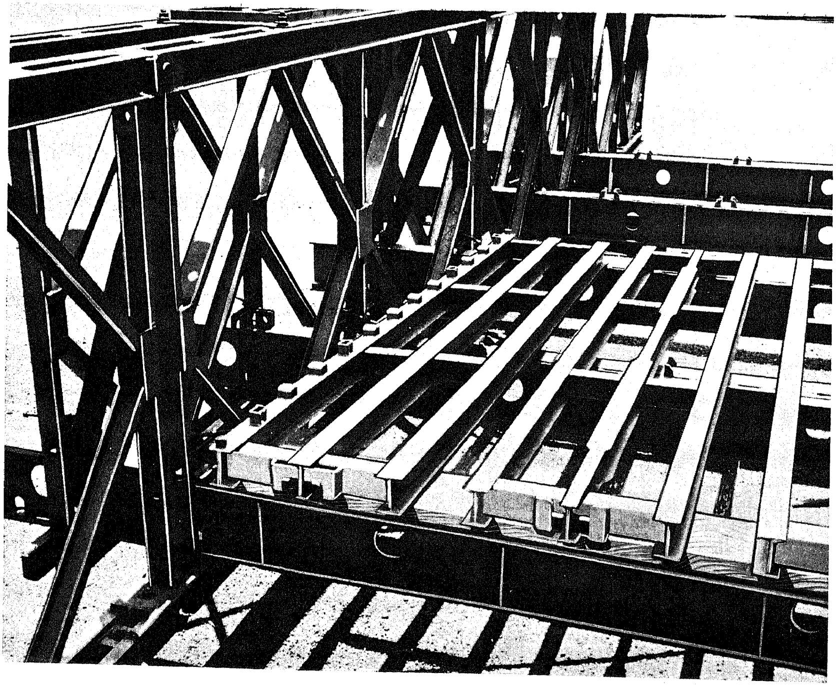


Figure 7–14. Construction transom with chess behind front vertical of first bay to allow insertion of transom in end post after bridge has been launched.

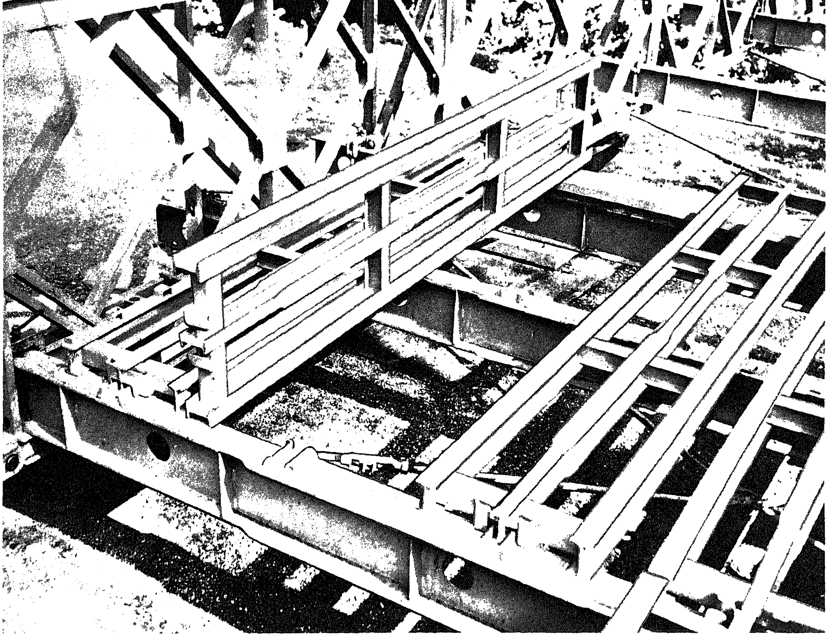


Figure 7–15. Stringer over sway-brace turnbuckle laid on edge to provide room for tightening sway braces. Sway braces in one bay are left loose until bracing is fitted for next bay being assembled.

e. Place a chess on top of transom behind front vertical in first bay and position stringers for first bay (fig 7–13 and 7–14). Leave stringer over sway brace turnbuckles on edge until sway braces have been tightened (fig 7–15). After bridge has been launched and when end-post transom is inserted, the chess holding up the stringers and decking in the first bay can be pushed clear with crowbars, and decking will drop into position.

f. Position panels of third bay and at the same time insert transoms in second bay, one in front of middle vertical and one in front of rear vertical (fig 7–16).

g. After transoms are in position in second bay, fix sway braces, rakers, and bracing frames loosely (fig 7–17). Install rakers only on transoms at end verticals.

h. Tighten bracing in first bay, and deck first bay (fig 7–18).

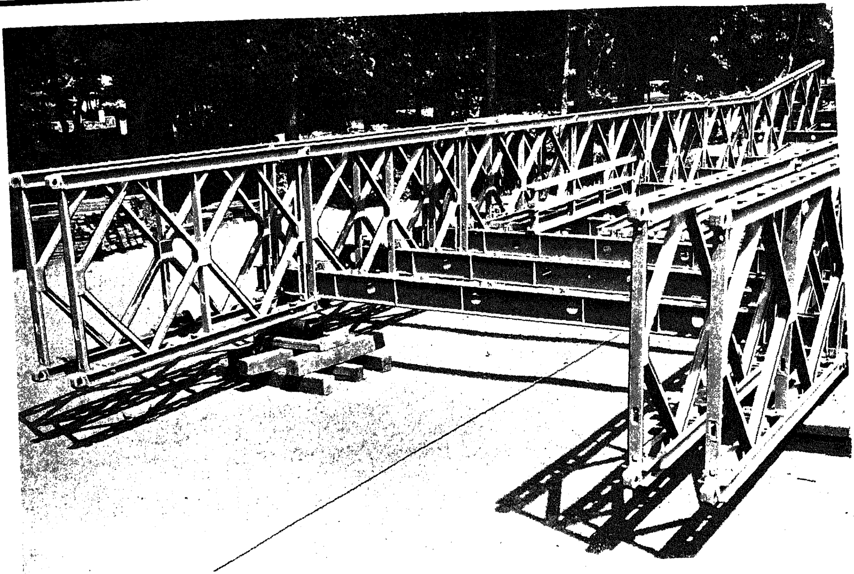


Figure 7–16. First bay, DS, assembly—third bay of panels and second bay transoms added.

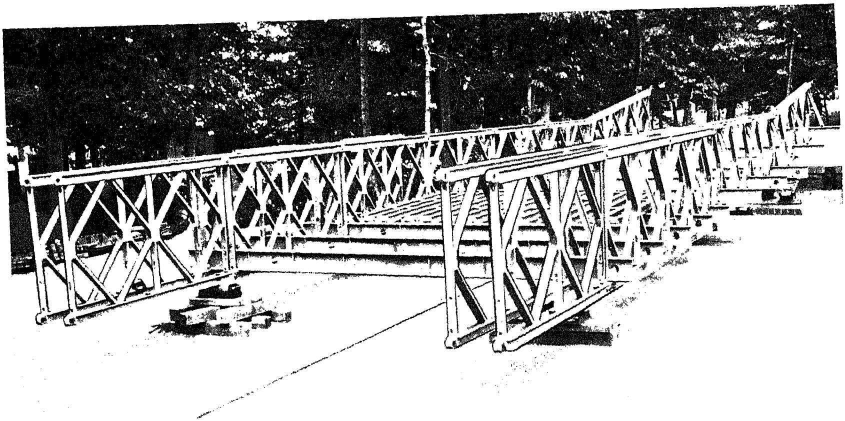


Figure 7–17. First bay, DS, assembly—sway braces, rakers, and bracing frames added in second bay.

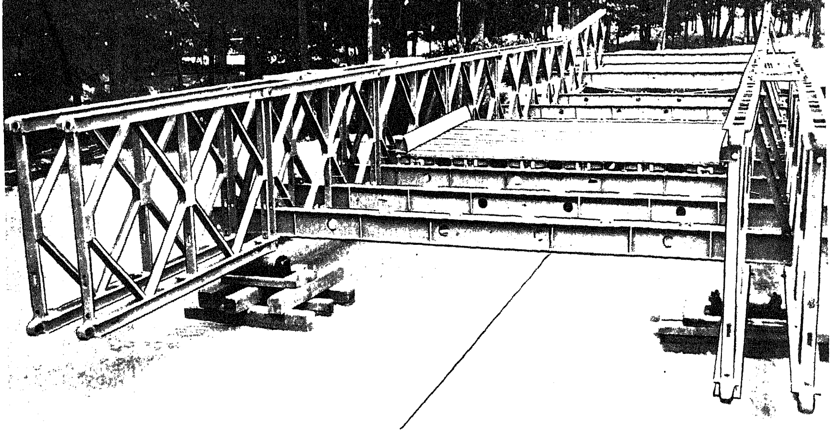


Figure 7–18. First bay, DS, assembly—first bay braces tightened and bay decked.

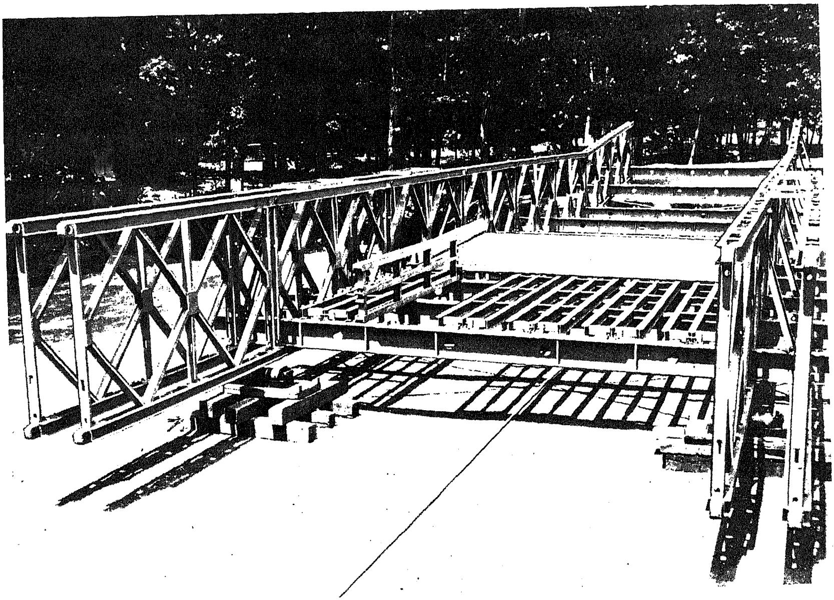


Figure 7–19. Assembly of remainder of DS bridge—stringers positioned in second bay.

7–5. Remainder of Bridge

a. Position stringers in second bay and leave stringer over sway brace turnbuckles on edge until sway braces have been tightened (fig 7–19).

b. Add fourth bay of panels and at same time insert transoms in third bay (fig 7–20).

c. Add bracing in third bay. Tighten bracing in second bay, and deck second bay (fig 7–21).

d. The sequence is complete. The same sequence is used for the rest of the bridge. All jobs proceed at the same time and the sequence is used to prevent crowding of assembly and carrying parties.

e. Normally, footwalks are not used. However, when time, men, and materials are available, footwalks can be assembled. Footwalks should be assembled before launching because it is awkward

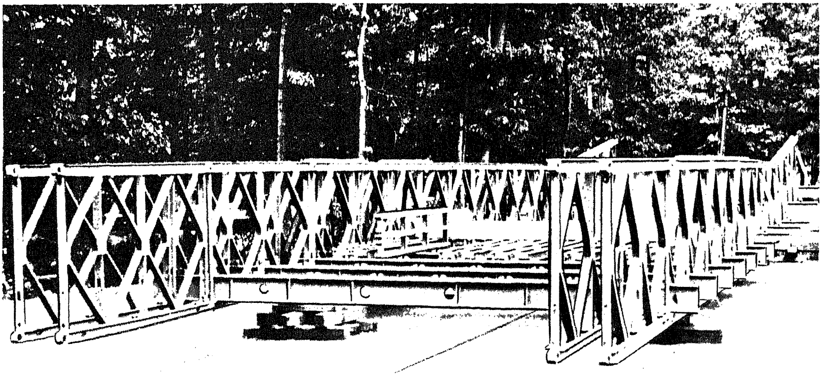


Figure 7–20. Assembly of remainder of DS bridge—fourth bay of panels and third bay transoms added.

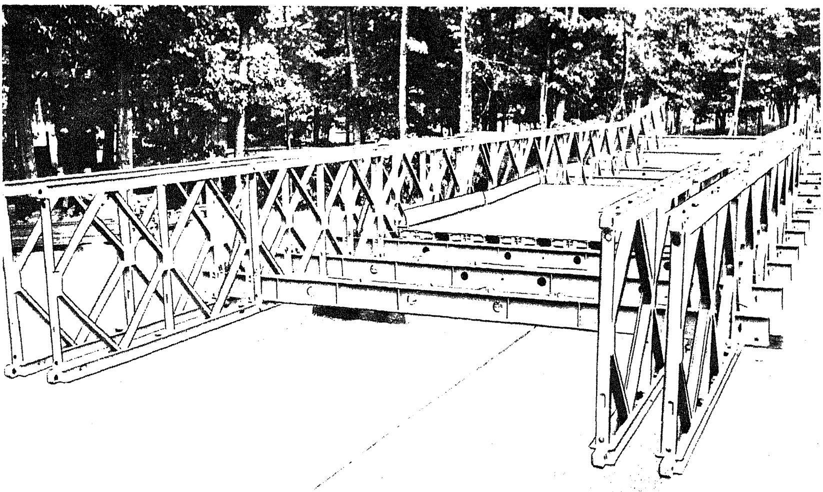


Figure 7–21. Assembly of remainder of DS bridge—third bay bracing added, second bay bracing tightened

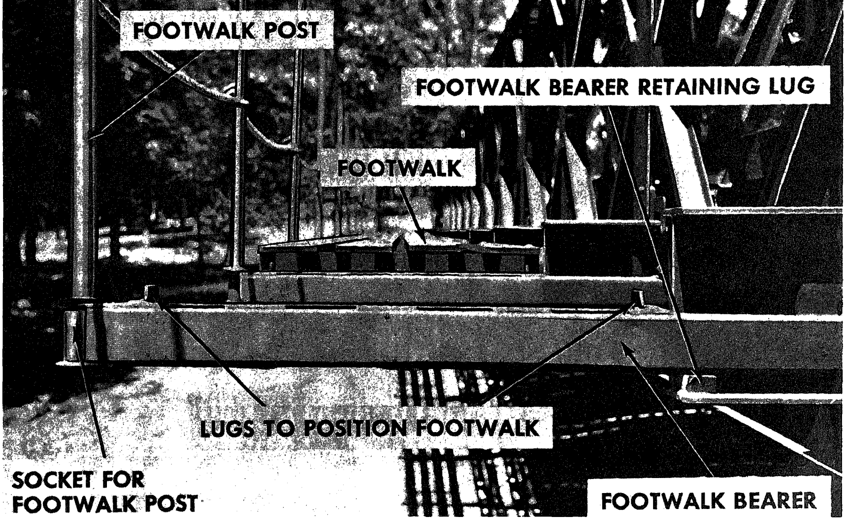


Figure 7–22. Footwalk.

to place bearers and footwalks after bridge is in place. Bearers are attached to all transoms. They fit over and under special lugs welded to the transom. Footwalks are positioned by lugs on bearers. Footwalk posts are inserted in sockets at the ends of bearers and hand ropes threaded through the eyes of the posts. Figure 7–22 shows the completed footwalk.

Section III. ASSEMBLY OF TRIPLE-SINGLE BRIDGE

7–6. Method of Assembly

The method of assembly for the triple-single bridge is similar to that for the double-single. The assembly of the outer truss must delay one bay, however, so panel pins in the second truss can be inserted. In addition, short pins must be used in the middle and outer truss end posts because normal length pins will not fit.

7–7. Nose

The assembly of the launching nose for TS bridges (table 7–3) is the same as the assembly of the launching nose for DS bridges (table 7–2).

7–8. First Bay of Bridge

Assemble the first bay of the bridge as follows:

a. Connect first two panels of inner truss with last bay of nose. Insert first transom in front of middle vertical and clamp loosely with transom clamp (1, fig 7–23).

b. Add panels of middle truss in first bay and hold in place with transom clamps (2, fig 7–23).

c. Insert second transom in front of rear vertical. Attach rakers and position bracing frames and sway braces (3, fig 7–23). The construction transom behind front vertical is omitted until the outer truss in the first bay has been positioned.

d. Add middle truss panels in second bay (4, fig 7–23). This panel must be positioned before the outer truss panel in the first bay so panel pins can be inserted.

e. Add outer truss panels to first bay. Position construction transom behind forward uprights in first bay. Add inner truss panels to second bay (5, fig 7–23).

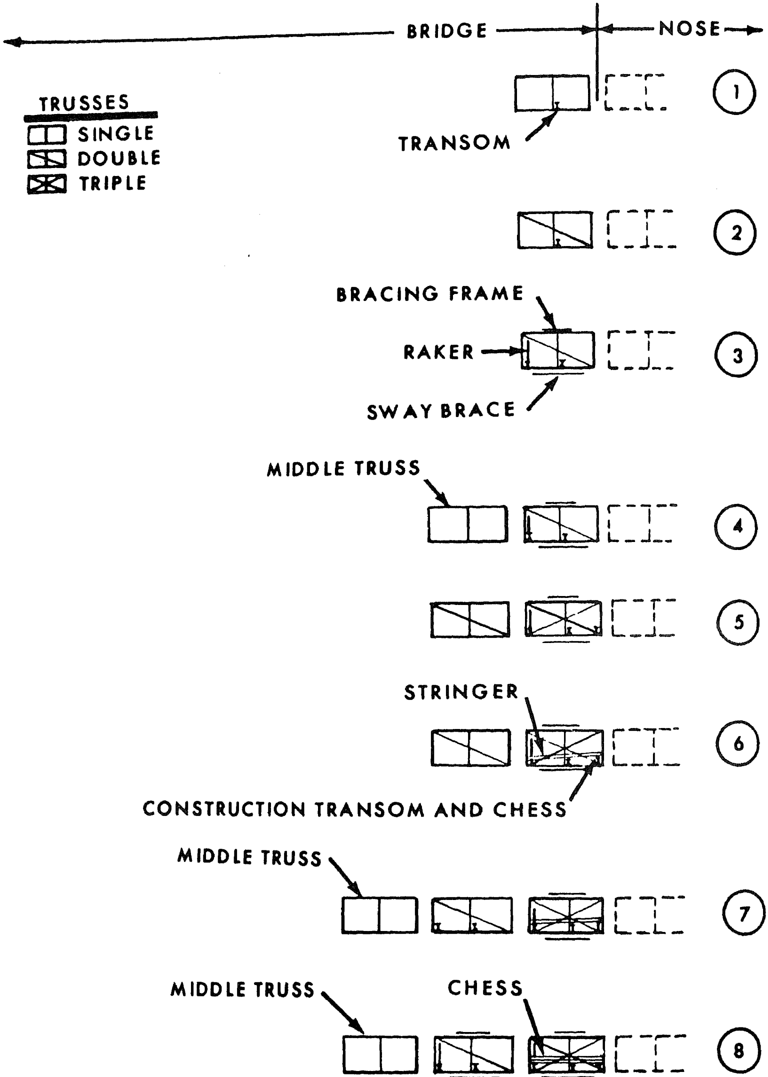


Figure 7–23. Assembly of first bay of triple-single bridge.

g. Position middle truss panels in third bay and at the same time insert transoms in second bay, one in front of middle vertical and one in front of end vertical (7, fig 7–23).

h. Add bracing in second bay. Tighten bracing in first bay and deck first bay (8, fig 7–23).

7–9. Remainder of Bridge

a. Position outer truss of second bay and connect to middle truss with tie plates bolted to top raker holes in forward uprights of panels (fig 7–24). Add inner truss of third bay (fig 7–25). Figures 7–26 and 7–27 show the position of panel pins in TS bridge.

b. Place stringers in second bay. Position middle truss panels in fourth bay and at same time insert transoms in third bay (fig 7–25).

c. Add bracing in third bay. Tighten bracing in second bay and deck second bay (fig 7–25).

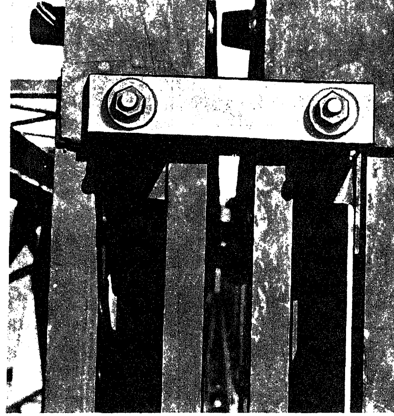


Figure 7–24. Tie plates between middle and outer trusses in triple-single bridge.

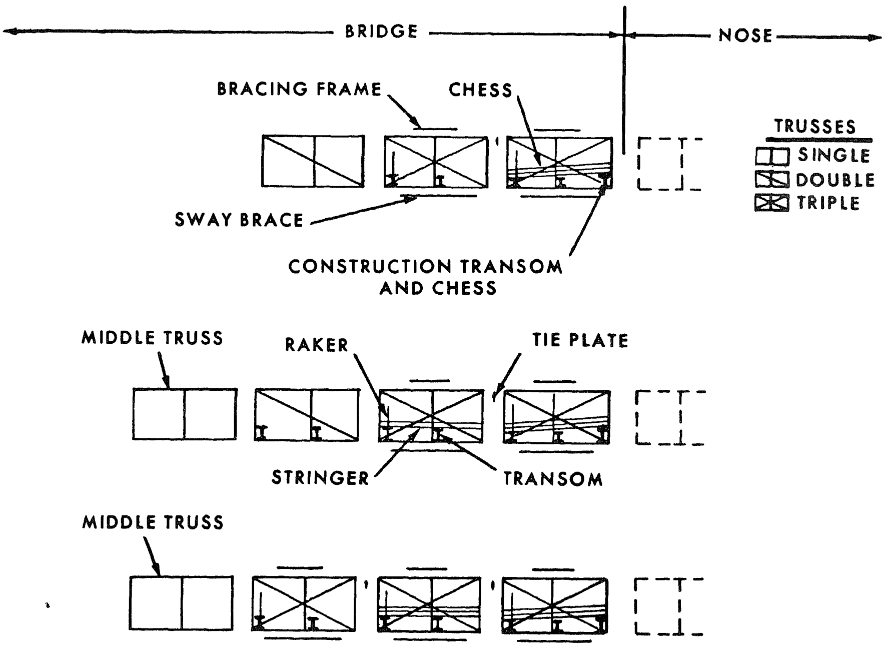


Figure 7–25. Assembly of remainder of triple-single bridge.

d. The sequence is complete and the same sequence is used for the rest of the bridge.

e. When greater than class 70 loads are to be carried, such as an 80-foot triple-single bridge, four transoms per bay are required. The procedure for assembling the transoms in the first bridge bay is the same as in paragraph 7–4*a* and *c*. In addition a fourth transom is added behind the center vertical. In order to clamp both transoms at the center vertical the transom held be-

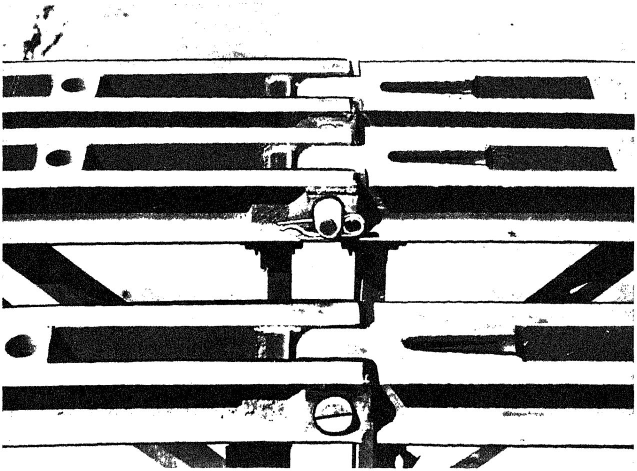


Figure 7–26. Position of panel pins in triple-single bridge—pins in main part of bridge.

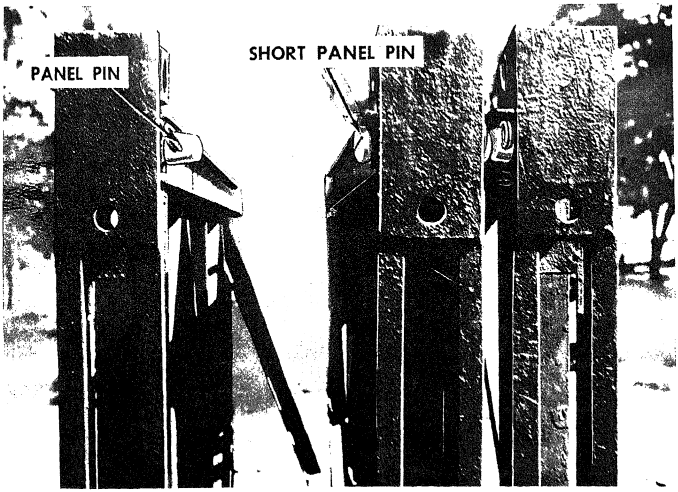


Figure 7–27. Position of panel pins in triple-single bridge—use of short panel pins in end posts.

hind the center vertical should be clamped to the inside trusses and the other to the outside trusses. In all subsequent bays, the four transoms are placed in regular order, the first behind the front vertical, one in front of the center vertical, one behind it, and one in front of the rear vertical.

Section IV. LAUNCHING AND JACKING DOWN

7–10. Launching

a. Use of Counterweight.

(1) Single story bridges are normally assembled and launched by manpower. They can be assembled on the rollers and launched or the bridge and nose can be pushed out over the gap after every two bays are assembled. Pickets are inserted after each move to prevent rolling (fig 7–6).

(2) During launching, the entire bridge (including the nose) must be counterbalanced so the structure does not tip into the gap. The counterbalance is normally obtained by adding enough bridge behind the near-shore rocking rollers to act as a counterweight and keep the balance point between the plain rollers and the rocking rollers. This condition must prevail until the launching nose reaches the rollers on the far bank. This point is illustrated in tables 7–1 through 7–3 which show the bridge and launching nose just spanning the gap; in this position the bridge is completely assembled and the balance point is slightly behind the near-shore rocking rollers. As the bridge is pushed on across the gap from this position, the balance point passes the rocking rollers. The part of the bridge acting as a counterweight is no longer needed to maintain balance because there is now no danger of tipping into the gap.

Note. It is, however, needed to avoid excess stress in the launching nose until launching is completed.

Dismantling any of the bridge behind the rocking rollers will throw additional stress on the launching nose and on the part of the bridge which is across the gap. This may result in failure of the nose.

Caution. **The near-bank rocking rollers and the far-bank rocking rollers must carry the entire**

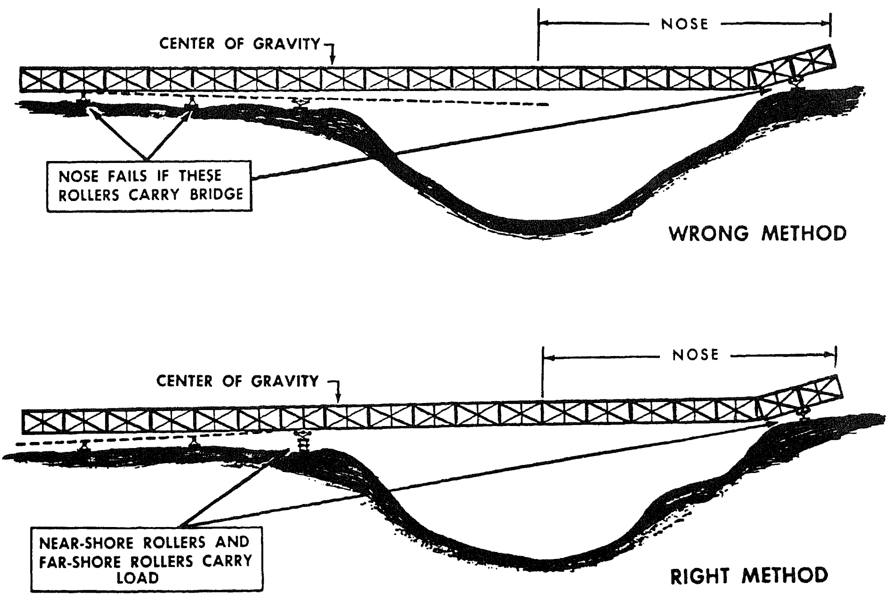


Figure 7–28. Position of rollers. Once launching nose rests on far-bank rocking rollers, bridge must clear the near-bank plain rollers and must remain clear of them.

load after the launching nose reaches the far-bank rocking rollers (fig 7–28). The launching nose may fail if the near-bank plain rollers are permitted to carry any load after the nose reaches the far-bank rocking rollers. The rear of the bridge must hang free to act as a counterweight. This is done by cribbing up the near-bank rocking rollers, or removing plain rollers so the rear end of the bridge does not rest on them after the launching nose reaches the far-bank rocking rollers. If removal of plain rollers does not provide the required clearance, excavate until the overhang is free of the ground.

If the far-bank rocking rollers are placed several inches below the level of the other rollers, settlement by the entire dead weight of the bridge on the near-bank rocking rollers will be offset so that the resulting launching plane will be level or erring on the safe side. In addition, the extra 6 inches safety allowance in the positioning of the nose links will help prevent a free unsupported length of bridge from the far-bank rocking rollers to the first near-bank plain rollers clear of the rocking rollers. Once the links have passed over the far-bank rollers, check the launching plane. If too much settlement has occurred on the near bank, remove the plain rollers.

b. Completion of Assembly and Launching. After the nose and first bay of the bridge have been completed, proceed with launching as follows:

(1) One pair of plain rollers has been placed 25 feet behind the rocking rollers. Additional plain rollers are not required when launching bridges up to 80 feet long. Bridges over 80 feet long require additional sets of plain rollers spaced at 25-foot intervals. Bridges are assembled on the rollers. When necessary, jacks are used to aid insertion of the lower panel pins of panels resting on rollers.

(2) Continue assembly of bridge and rolling out on rollers (fig 7–29). When the forward end of the launching nose reaches the rollers on the far bank (fig 7–30), a detail guides it onto the rollers (fig 7–31) and dismantles it bay by bay (fig 7–32).

(3) When the end of the bridge proper clears the rollers on the far bank, attach the near-bank end posts. At the same time, attach the far-bank end posts and lay a transom across their steps. The middle and outer truss end posts on the triple truss bridge are pinned with short panel pins and tied together with tie plates in the raker holes. Pins in middle truss end posts are inserted with points outward and in outer truss end posts with points inward (fig 7–26 and 7–27). Normal pins and normal methods of pinning are used on the front vertical in the first bay so decking drops into place.

c. Precautions.

(1) Do not use bent or distorted parts.

(2) Do not attempt to convert the launching nose into the bridge by adding parts to it.

(3) In launching the bridge over rollers, keep the center of gravity behind the rocking rollers until the launching nose reaches the far bank. Thereafter, do not dismantle the bridge behind

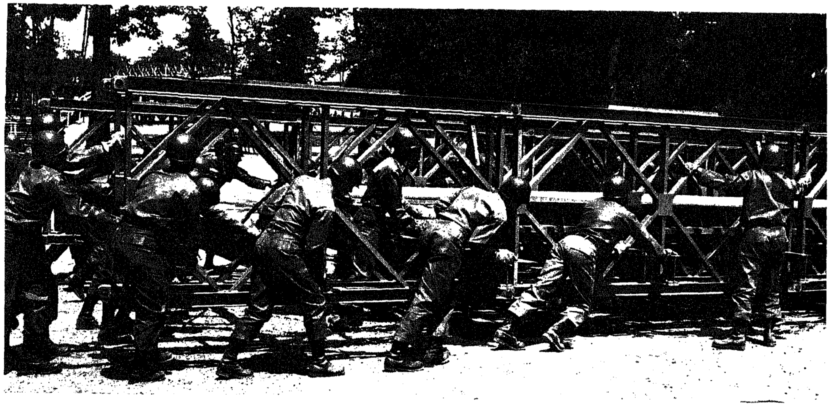


Figure 7–29. Pushing bridge over gap.

(4) After the launching nose passes over the

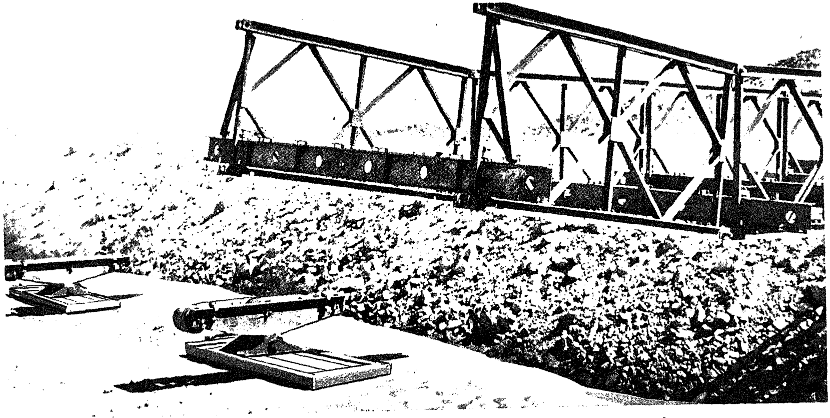


Figure 7–30. Launching nose approaching far bank; rocking rollers in place.

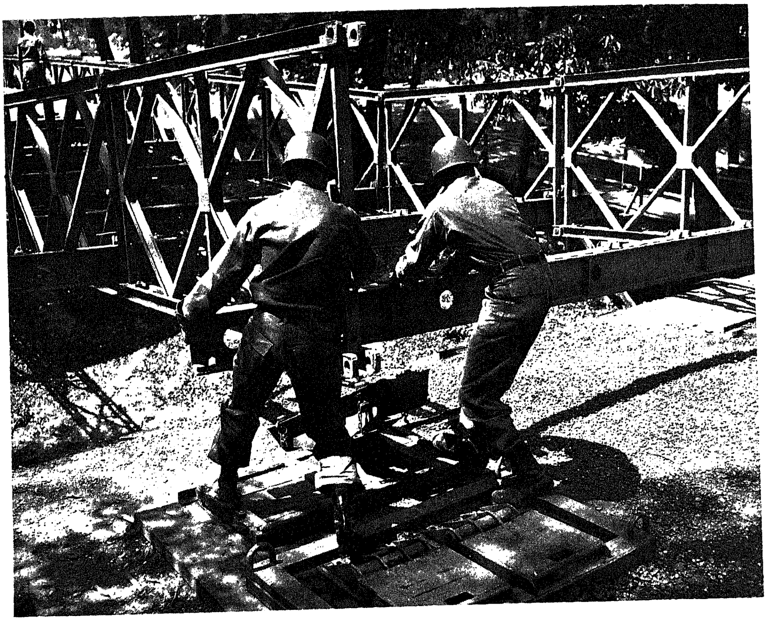


Figure 7–31. Guiding launching nose onto rocking rollers.

7–11. Jacking Down

After the end posts and end transom have been installed, proceed with jacking down as follows:

a. Place jack shoe on base plate and jacks on shoes with toes of jacks under steps of end posts (fig 7–33). Only enough room is present to work four jacks at one end of the bridge. Additional jacks may be placed under a transom only when held by end posts. Jacks must be operated in unison so the load is distributed evenly between them to prevent failure of jacks.

Note. Pitch of teeth may vary in jacks of different manufacture. Jacks used together must always have the same pitch.

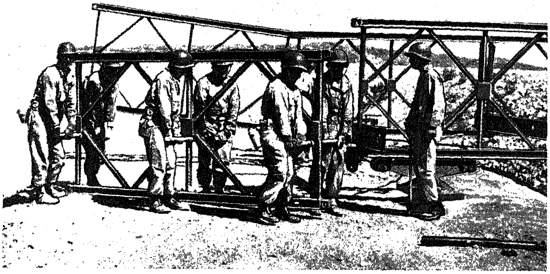


Figure 7–32. Dismantling launching nose.

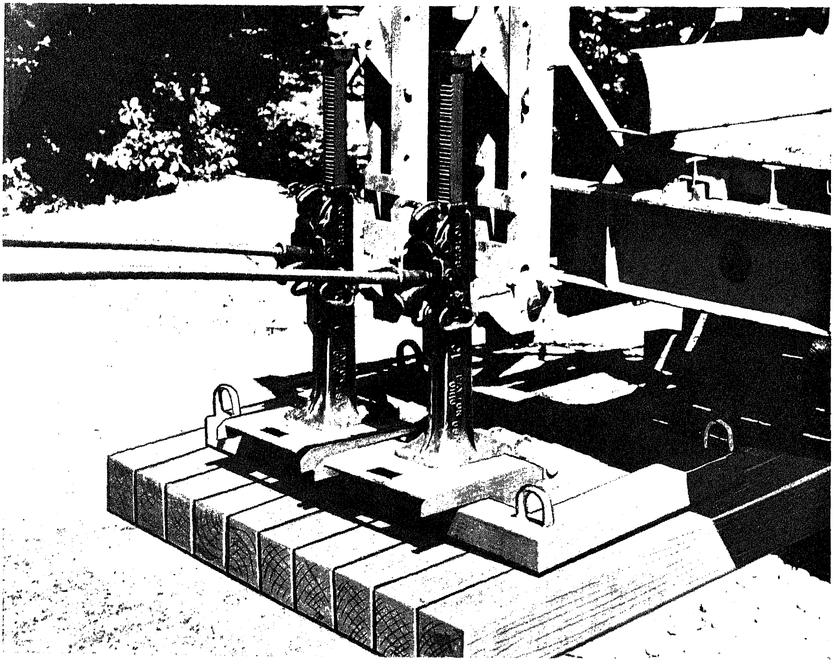


Figure 7–33. View of jacking operation showing the placement of the jack, jack shoe, and bearing.

Figure 7–34. Jacking bridge.

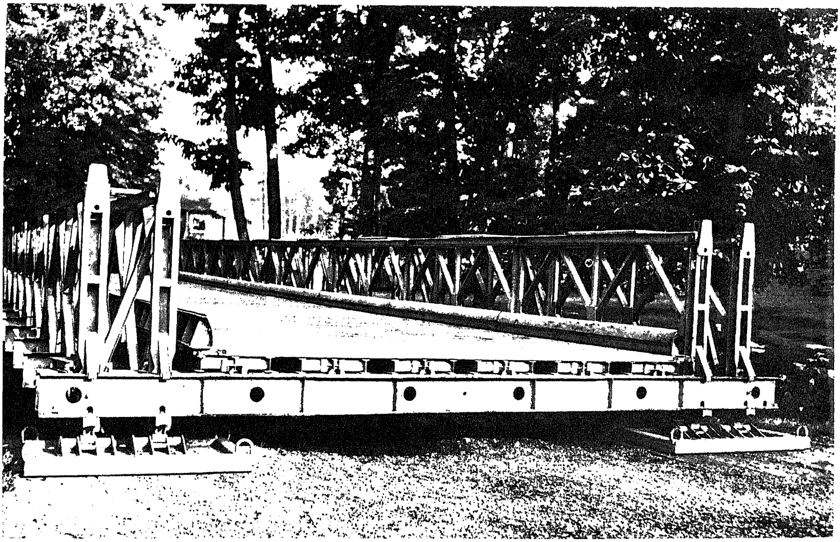


Figure 7–35. End of bridge jacked down on bearings.

b. Jack up the ends of the bridge successively and remove the rocking rollers (fig 7–34). Place bearings on base plate as shown in figure 6–10.

c. Lower bridge in stages (fig 7–34 and 7–35). Place cribbing under the bottom chord of the trusses to catch the bridge if it slips off the jacks. It does not matter which end of the bridge is lowered first, but the jacks must be operated in unison.

Note. Jacks must be operated only on one end at a time.

Section V. RAMPS

7–12. Cribbing

Before placing ramps, the end transoms of the bridge must be cribbed if the bridge is to carry loads of 40 tons or more (para 5–13). In addition, for loads of 45 tons or more, ramps must be cribbed and wedged at the midpoint (para 5–12).

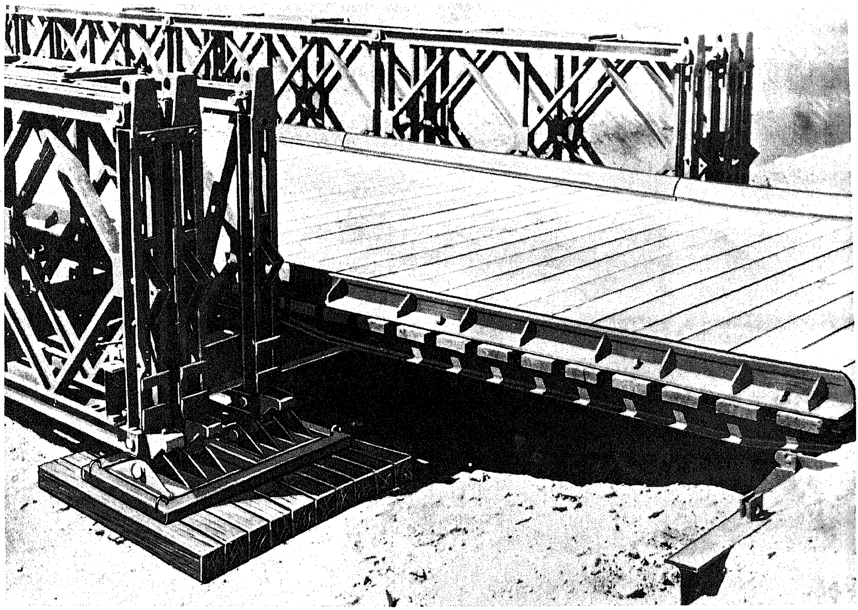


Figure 7–36. Single-bay ramp completely decked.

Cribbing and wedges must be properly drift-pinned or nailed to prevent shifting under traffic. If the slope of ramp is not over 10 to 1, only one bay of ramp is necessary (fig 7–36). When two bays are needed, they are supported by four ramp pedestals resting on the ground or grillage (fig 5–22 and 7–37). Ramp bays are decked the same way as bays of the bridge proper.

7–13. Assembly

After the end transoms of the bridge are cribbed (if necessary) proceed with the assembly of the ramp as follows:

a. Position sill for end of ramp as described in paragraph 5–12*a*. If ramp is to be a two-bay ramp, position ramp pedestals and transom (fig 7–37 and 5–22).

b. Position ramps and add decking (fig 7–36 and 7–38).

c. Brace approach to ramps and the bridge is complete.

Section VI. REINFORCING BRIDGE

7–14. Procedure

a. The class of existing single- and double-truss bridges can be increased by the addition of extra trusses. Construction starts from the center of the bridge, and panels are added toward each end. Panel levers are used to aid in positioning the extra panels (fig 7–39).

b. For all assemblies over class 70, the floor system must be reinforced by increasing the number of transoms per bay from two to four, and by adding a 3-inch longitudinal wear tread. These transoms can be threaded a bay at a time from inside the bridge.

7–15. Converting Single-Single to Double-Single

To convert an existing SS bridge to a DS bridge, proceed as follows:

a. Remove footwalk (if any).

slings at ends of panel and position with levers (fig 7–39).

d. Insert transom clamps and tighten. Tightening transom clamps helps reduce difficulty caused by sag.

e. Position second panel, insert transom clamps and tighten. Insert panel pins (point inward) first in bottom and then in top of panel.

f. Connect outer truss to the inner truss with bracing frames bolted to top chord. Continue add-

Caution. **At the end of bridge where the transom is in the end post, panel and end post must be added as one unit.**

h. Position bearings for double-truss assembly, jack bridge down on bearings, and replace footwalks (if any).

i. Check to assure that the existing grillage is strong enough to carry the reinforced class.

j. Figure 7–40 shows a complete double-single bridge with footwalk.

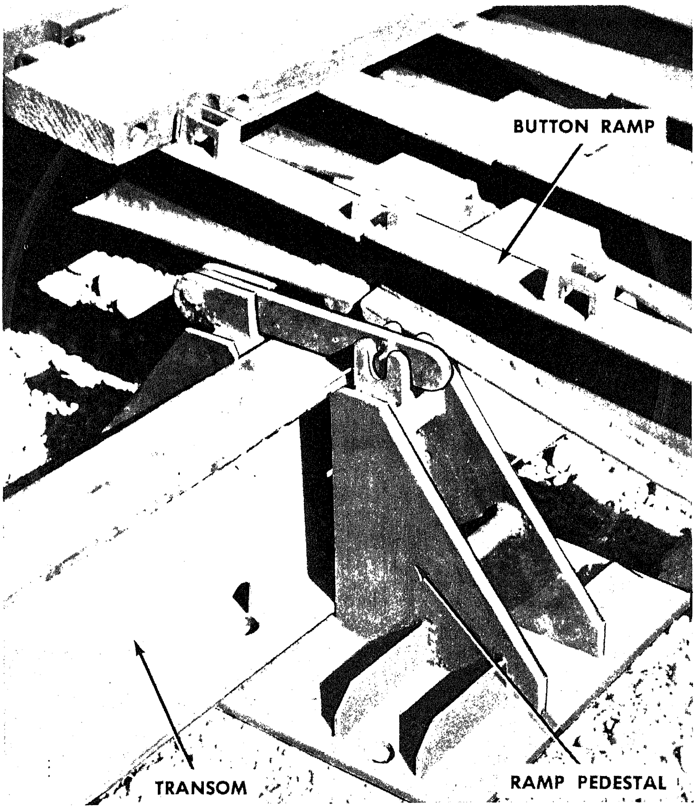


Figure 7–37. Closeup of ramp pedestal supporting transom.

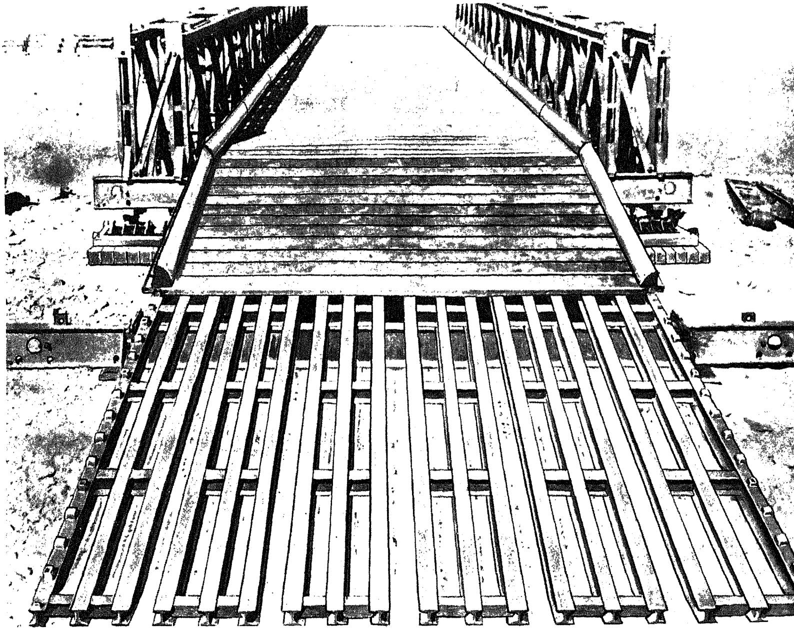


Figure 7–38. Two-bay ramp with chess laid on first bay.

Figure 7–39. Inserting panel of outer truss. Note use of levers and chain slings to lower panel into position.

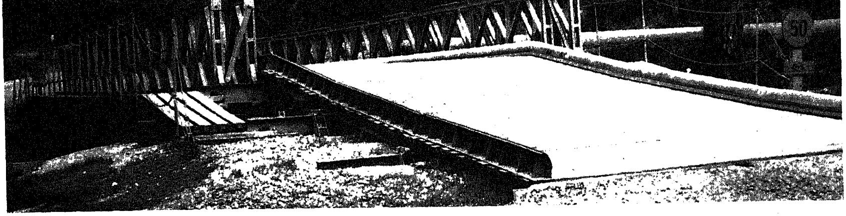


Figure 7–40. Double truss single-story bridge with footwalk.

7–16. Converting Double-Single to Triple-Single

To convert an existing DS bridge to TS bridge, proceed as follows:

a. Use same procedure as for converting SS bridge to DS bridge for steps *a* to *e*.

b. Connect outer truss to middle truss with tie plates bolted to top raker holes in the same upright of successive panels (fig 7–24). Continue adding panels toward each end of bridge.

c. Jack bridge off bearing (ramps need not be removed) and crib under first and second truss (fig 7–41).

Note. Cribbing must not extend out beyond second truss.

d. Install end panel and end post by raising into position with levers (fig 7–42).

Note. At the end of the bridge where the transom is in the end post, the panel and end post must be added as one unit.

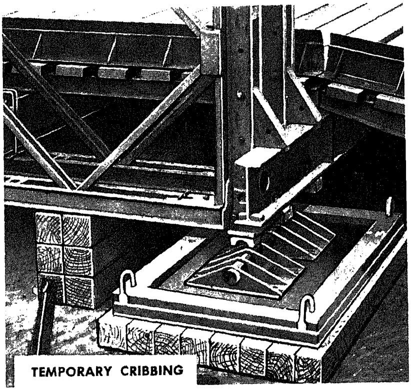


Figure 7–41. Double-truss bridge jacked up and cribbed at end where transom is in end post before insertion of outer truss.

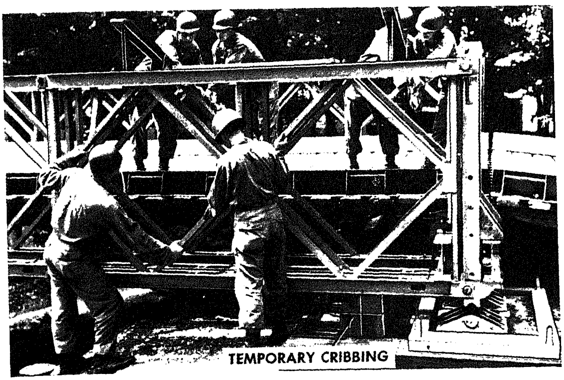


Figure 7–42. Inserting outer truss. Panel and end post must be installed as one unit at end where transom is in end post. Note use of levers to raise panel into position.

tal. Add tie plates.

f. Shift bearings for double-truss assembly to

bearings for triple-truss assembly (fig 6 ... down bridge on bearings (fig 7–43).

g. Replace footwalk if needed.

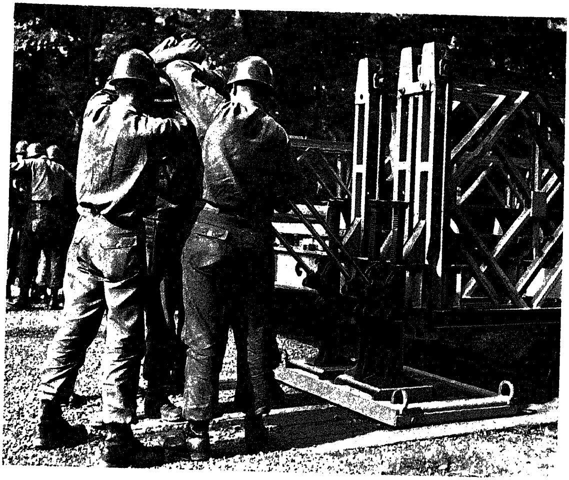


Figure 7–43. Jacking down after inserting the outer truss and shifting bearings.

Section I. GENERAL

8–1. Methods of Assembly

Methods of assembly for double-story bridges are similar to those used for single-story bridges. For placing second-story panels, however, the panels can be manhandled from trucks or other platforms. Truck-mounted cranes, 5-ton wreckers, or gin poles can also be used. It is possible to assemble the second story during bridge assembly or after the bridge has been entirely launched. It is preferable, however, to assemble the entire bridge before pushing it across the gap.

8–2. Methods of Launching

The same methods of launching are used as for single-story assembly. For long heavy bridges, it may be necessary to use a bulldozer or trucks.

Section II. LAUNCHING NOSE

8–3. Composition

The composition of the launching nose for the various combinations of span and truss type is given in tables 8–1 and 8–2.

8–4. Use of Tables

The tables must be followed exactly with respect to the composition of the launching nose.

Table 8–1. Launching Nose Composition for Double-Double Bridges

SPAN (FEET)	LAUNCHING WT (TONS)	SAG (INCHES)
100	60.5	17
110	59.0	22
120	63.5	24
130	69.0	31
140	76.0	38
150	81.5	41
160	75.5	45
170	81.0	57
180	76.0	68

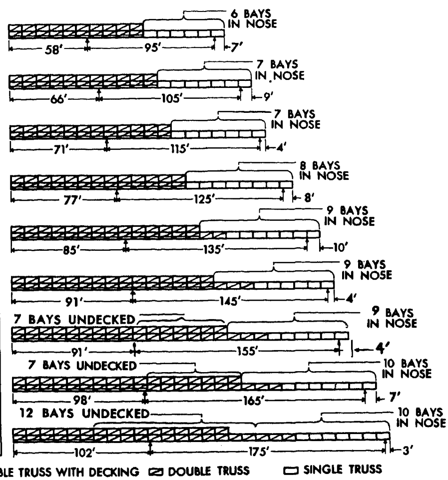
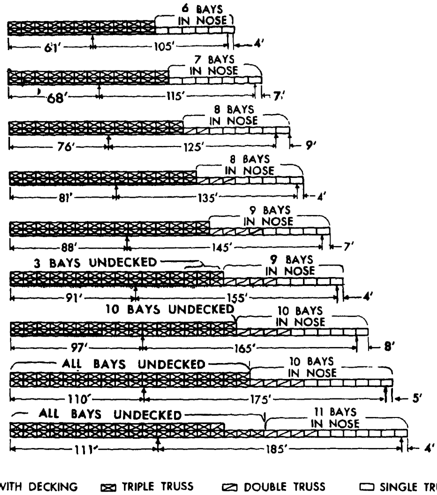


Table 8–2. Launching Nose Composition for Triple-Double Bridges

SPAN (FEET)	LAUNCHING WT (TONS)	SAG (INCHES)
110	79.4	17
120	87.1	22
130	86.0	29
140	93.0	31
150	100.0	39
160	101.5	42
170	98.0	53
180	93.5	60
190	91.5	78



Section III. ASSEMBLY OF DOUBLE-DOUBLE BRIDGE

8–5. First Bay of Bridge

When assembly of the nose is completed, assembly of the first bay of the bridge is as follows:

a. Assemble three bays of DS bridge as shown in figure 8–1 and described in paragraph 7–4.

b. Begin double-story assembly in first bay of

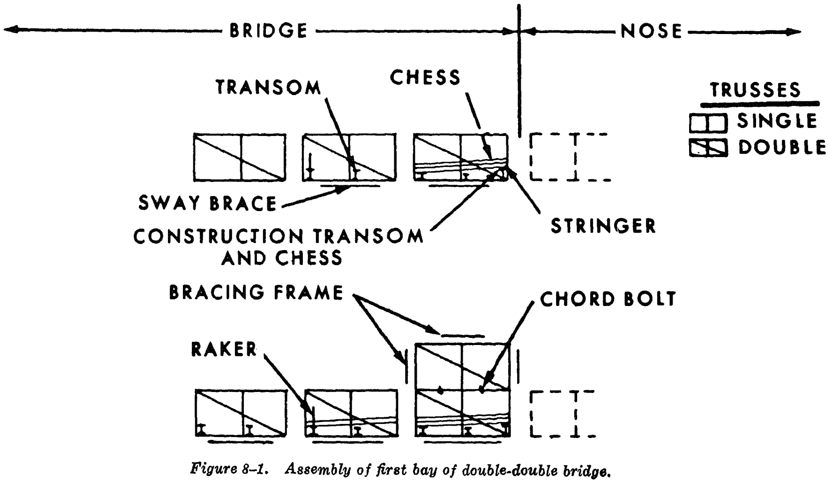


Figure 8–1. Assembly of first bay of double-double bridge.

erection platform when placing second-story panels. Footwalks can be used as a working platform or panels can be manhandled from trucks maneuvered alongside of the bridge (fig 8-2—8-4). Panels must be loaded on trucks to allow standing room in the truck for the working parties. The second story is assembled as follows:

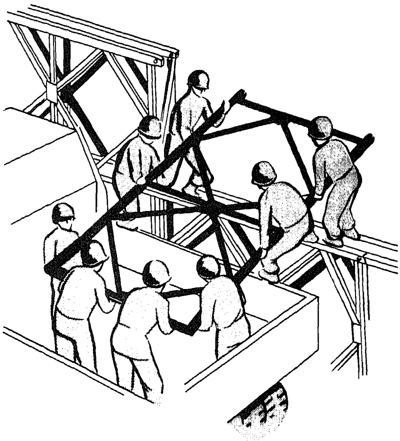


Figure 8-2. Adding second-story panels, using truck as working platform—picking up panel from truck.

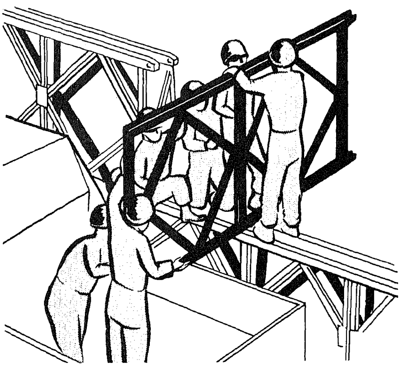


Figure 8-3. Adding second-story panels, using truck as working platform—lifting panel.

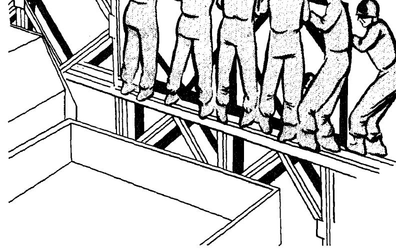


Figure 8-4. Adding second-story panels, using truck as working platform—placing panel.

(1) Pick up panel from truck at side of bridge, place flat on top chord of bridge. Slide panel in toward center of bridge.

(2) Lift panel upright. Pivot panel so it is parallel to existing truss. Position and pin panel and insert chord bolts, but do not tighten them.

(3) Repeat process with panels on outer truss.

(4) Position bracing frames on front and rear verticals and on top chord.

(5) Tighten chord bolts and bracing frame bolts.

(6) When footwalks are not used and trucks cannot be maneuvered alongside the bridge, second-story panels can be placed from a temporary deck inside the bridge or by the use of gin poles.

8-6. Remainder of Bridge

The remainder of the bridge is built the same as the first bay except that bracing frames are positioned on the rear verticals and top chord only (fig 8-5). When enough bays of bridge have been built to counterbalance the nose, move the bridge forward so the first bay is over the rocking rollers. Movement will not be necessary again during assembly unless the overhang at the tail causes excessive sag. When adding panels from outside the bridge, place inner panels first with panel pins inserted from the outside. Then place outer truss panels with pins inserted from the outside. When adding panels from inside the bridge, place the outer panels first and insert all pins from the inside.

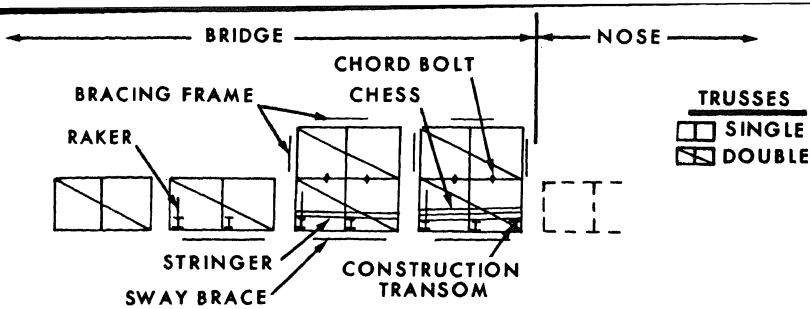


Figure 8–5. Assembly of remainder of double-double bridge.

Section IV. ASSEMBLY OF TRIPLE-DOUBLE BRIDGE

8–7. Method

The triple-truss double-story assembly (fig 8–6) is essentially the same as double-truss double-story assembly. With triple-truss assembly, however, the outer truss in both the lower and second story must lag by one bay to allow insertion of the panel pins in the middle truss when panels are added from outside the bridge. When second story panels are added from inside the bridge, the inner and middle trusses must lag by one bay to allow insertion of the panel pins in the outer truss.

8–8. Nose

The method of assembly of the launching nose is the same as for the DD bridge. For the length and assembly of nose required for various spans see table 8–2.

8–9. First Bay of Bridge

When assembly of the nose is completed, assemble the first bay of the bridge as follows:

a. Assemble four bays of TS bridge as shown in figure 8–7 and described in paragraphs 7–8 and 7–9.

b. Add double story assembly using the same assembly method as for the DD bridge (fig 8–1).

c. Position bracing frames on the front and rear verticals and on the top chord before the chord bolts are tightened.

8–10. Remainder of Bridge

Assemble the remainder of the bridge the same as the first bay except that bracing frames are positioned on rear verticals and top chord only. Connect outer truss to middle truss with tie plates bolted to top raker holes in forward uprights of panels in first and second story. See chapter 5 for ramp construction.

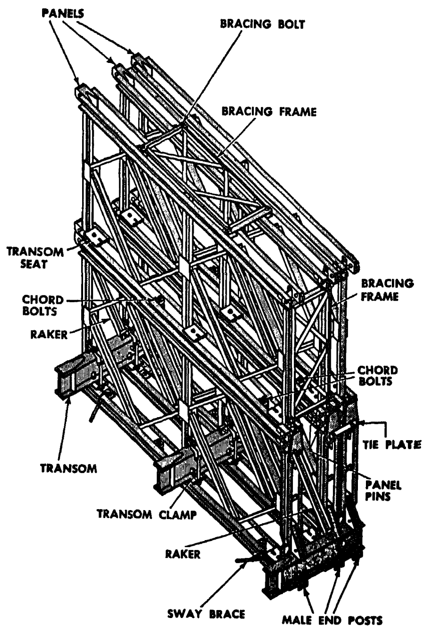


Figure 8–6. Location of bridge parts in trusses of triple-double bridge.

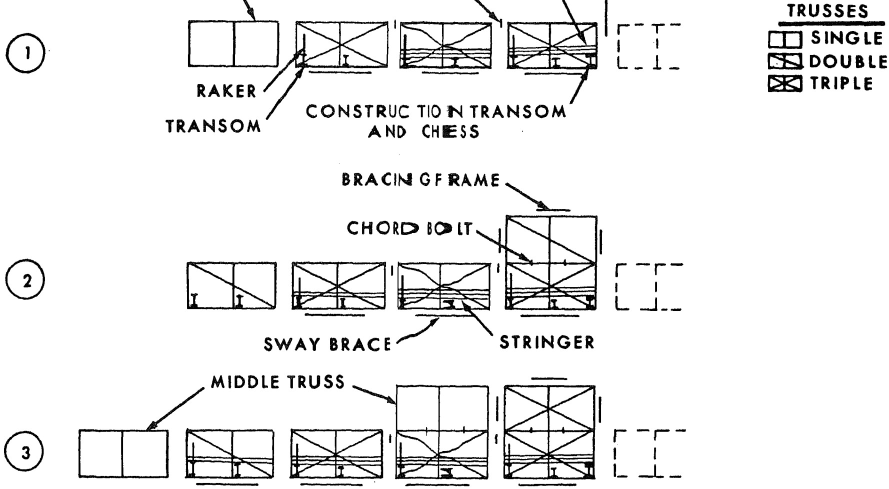


Figure 8–7. Assembly of first bay of triple-double bridge.

Section V. LAUNCHING AND JACKING DOWN

8–11. Launching

a. Methods. Launching of double-story bridges normally begins after the assembly of the entire bridge. Use the same launching methods and precautions as for launching single-story bridges. When launching with bulldozers or trucks, take the following precautions:

(1) Do not apply power directly to the end of a panel except at the junction of the diagonals. Apply it against the end posts, or a transom at the junction of the diagonals. When applying power against a transom, make sure it is distributed across the length of the transom.

(2) Roller heights must be fixed so that the tail of the bridge is at least 6 inches off the ground during the entire launching.

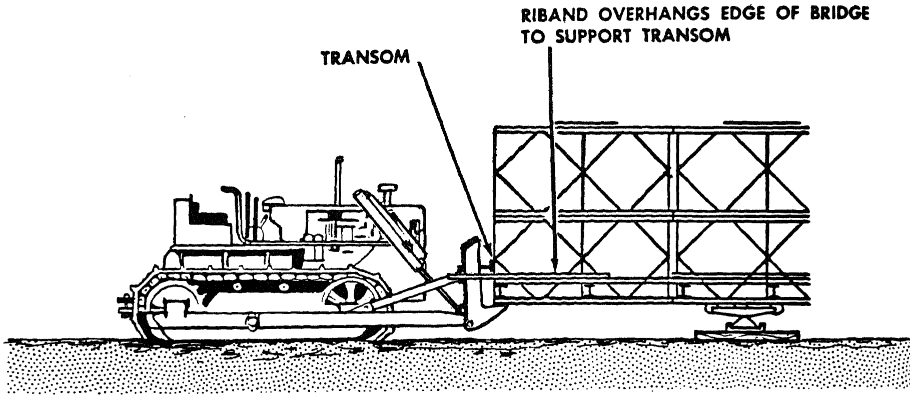
(3) Rig a snub line to control movement of the bridge.

(4) If the bridge requires two trucks or bulldozers to move it, use one against the end post of each girder.

b. Using Bulldozer. Bolt ribands at the tail of the bridge so they extend beyond the end of the bridge. Place a transom on its side on the ribands so that the transom rests against the end vertical of the junction of the diagonals. Face transom lugs toward the nose of the bridge. Snub the bridge by fastening winch lines from two trucks to male panel holes for positive control. Launch the bridge with bulldozer blade pushing against the transom (fig 8–8).

8–12. Jacking Down

The same jacking methods and precautions are used as for single-story bridges (para 7–11).



BULLDOZER PUSHES AGAINST TRANSOM LAID ON ITS SIDE ON TOP OF RIBANDS

Figure 8–8. Using bulldozer to launch bridge.

Section VI. REINFORCING BRIDGE

8–13. Method

a. The class of existing single-story bridges can be increased by adding extra stories.

b. For all assemblies over class 70 the floor system must be reinforced by increasing the number of transoms per bay from two to four, and by adding a 3-inch longitudinal wear tread.

8–14. Converting Double-Single to Double-Double

To convert an existing DS bridge to a DD bridge, proceed as follows:

a. Remove bracing frames.

b. Carry first panel to midpoint and place on top chord of existing bridge (fig 8–9). Erect outer truss first (fig 8–10). Before raising panels, insert wrenches in the top chord of the existing bridge to prevent the panel from skidding out. The inner truss assembly should follow closely behind the outer truss in order to speed up assembly.

c. Insert chord bolts and panel pins. Where necessary, use chord jacks (fig 8–11, 8–12, and 8–13) to overcome sag when inserting panel pins (fig

Figure 8–9. Placing outer-truss second-story panel for converting double-single to double-double bridge.

8–14). Tightening chord bolts also helps reduce difficulty caused by sag. *Chord jacks are not required* when adding a second story to double-truss spans 120 feet or less in length, if the following method is used simultaneously on both sides of the bridge:

(1) Place first panel of second story at center of bridge and insert chord bolts. Do not tighten bolts.

(2) Place a panel at each end of the first panel; insert chord bolts and upper panel pins.

(3) Tighten all chord bolts to reduce sag. Drive lower panel pins with sledge.

(4) After the first three panels are in place, add panels one at a time; work toward both ends of the bridge.

(5) As each panel is placed, insert chord

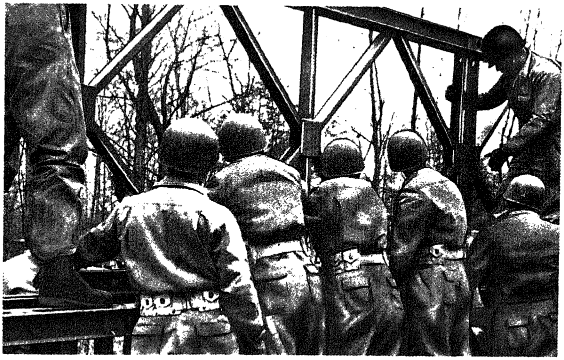


Figure 8–10. Outer second-story panel in position before insertion of panel pins.

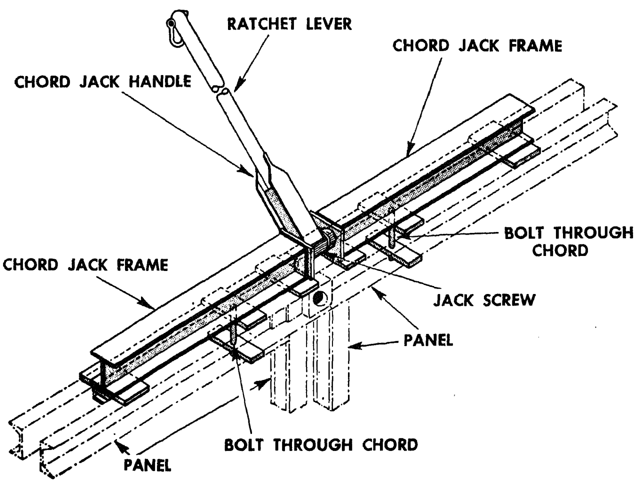


Figure 8–11. Chord jack in position on top chord.

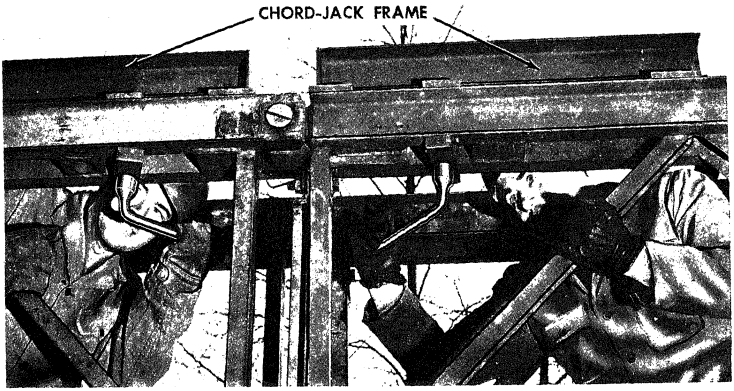


Figure 8–12. Installing chord-jack frames on top-story inside truss of double-double bridges.

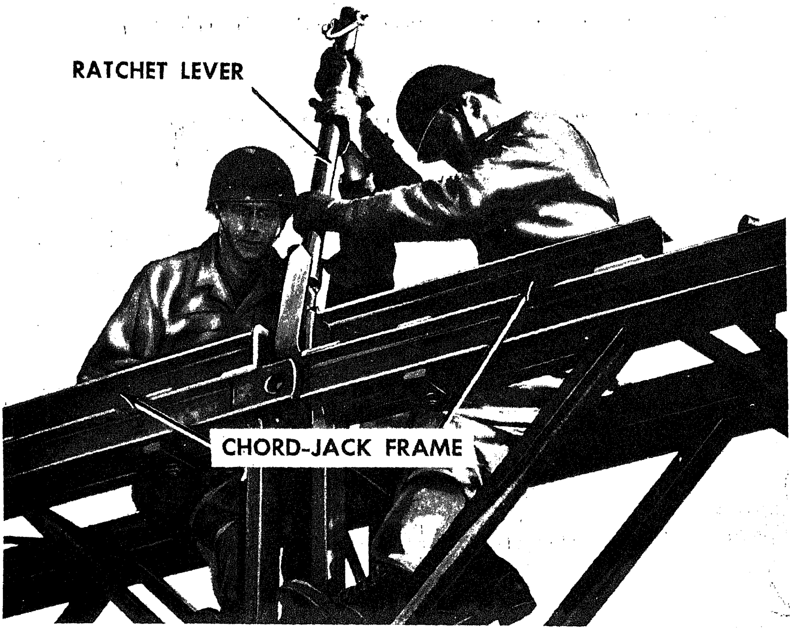


Figure 8–13. Using chord-jack to spread second-story panels of double-double bridge.

upper and lower panel pins simultaneously near the ends of the bridge. Take up on the chord bolts to reduce sag.

e. See figures 8–15, 8–16, and 8–17 for partially completed and completed bridge.

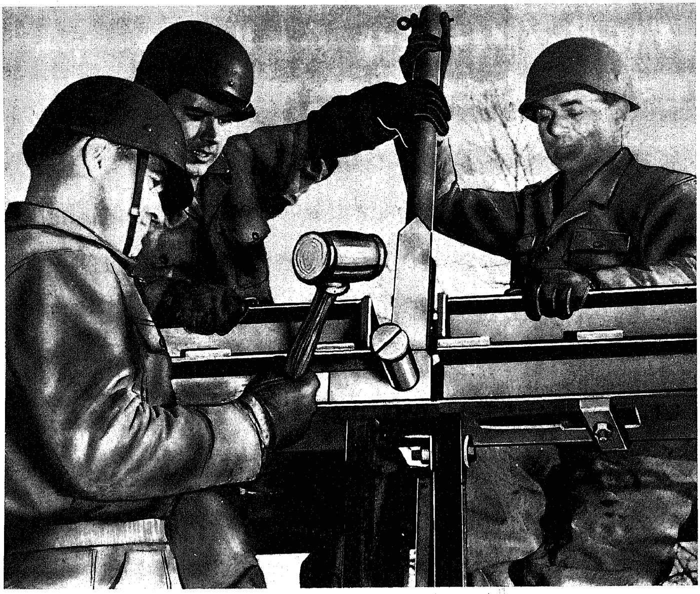


Figure 8–14. Driving panel pin in second-story panel using chord jack to spread panels.

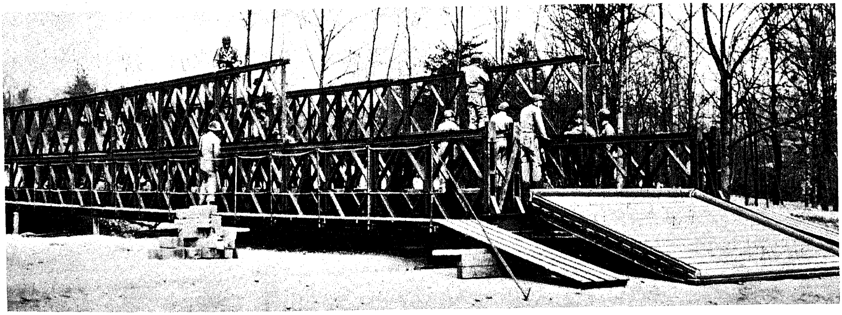


Figure 8–15. Converting double-single to double-double bridge in position.

Figure 8–16. . Completed double-double bridge.

Figure 8–17. Truck traffic over double-double panel bridge.

CHAPTER 9

ASSEMBLY OF TRIPLE-STORY BRIDGES

Section I. GENERAL

–1. Methods of Launching

'he normal cantilever method used for launching ingle- and double-story bridges is used for ıunching triple-story bridges. However, some of ıe triple-story bridges must be launched incom- lete to reduce the launching weight.

–2. Methods of Assembly

riple-story bridges are normally assembled by ruck-mounted cranes. If cranes are not available, arts can be placed with gin poles, 5-ton wreckers, r by manhandling. Triple-story bridges can be assembled with all three stories above the floor system (fig 9–1), or with one story underslung (fig 9–2). When all three stories are above the floor system, the top chord of the upper story must be braced laterally with transoms and sway braces. When one story is below the floor system, lateral bracing in the bottom chord of the under-slung story is required only when the wind velocity is more than 50 miles per hour. The class of triple-story bridges is not affected by the location of the deck or the omission of one story of panels in each end bay.

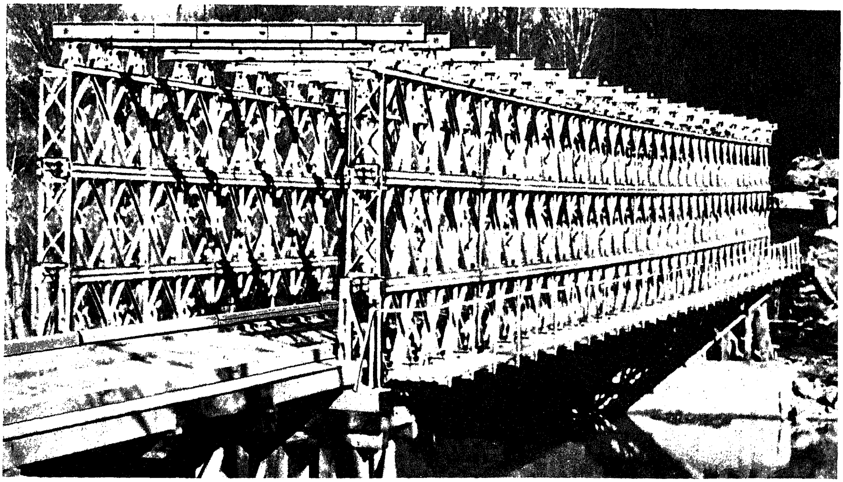


Figure 9–1. Triple-story bridge with all three stories above the floor system.

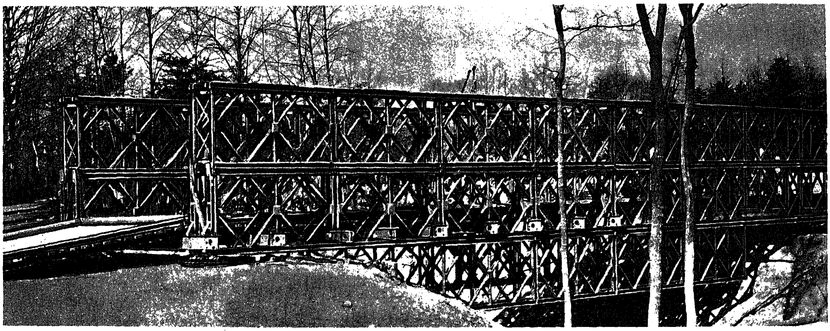


Figure 9–2. Triple-story bridge with underslung story.

Section II. LAUNCHING NOSE

9–3. Method

The method of assembly of the launching nose for triple-story bridges is the same as for single- and double-story. However, the launching weight of nose and bridge is limited by the 120-ton capacity of the near bank rocking rollers and the lower bridge chords which they support.

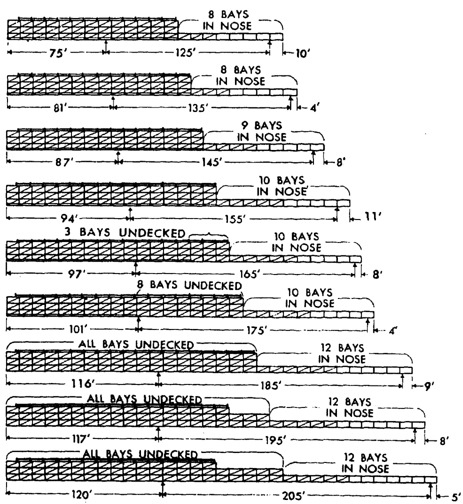
9–4. Composition

The composition of the launching nose for the various combinations of span and bridge assembly is given in tables 9–1 and 9–2.

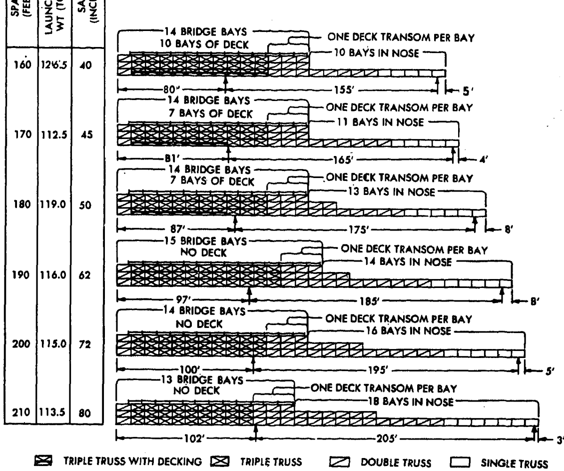
Note. The tables must be followed exactly with respect to the composition of the launching nose.

Table 9–1. Launching Nose Composition for Double-Triple Bridges

SPAN (FEET)	LAUNCHING WT (TONS)	SAG (INCHES)
130	104.2	25
140	101.0	27
150	109.0	34
160	117.0	42
170	119.0	45
180	118.5	47
190	111.0	60
200	110.5	72
210	112.0	80



DOUBLE TRUSS WITH DECKING DOUBLE TRUSS SINGLE TRUSS



Section III. OVERHEAD BRACING

9–5. Method

The upper story of triple-story bridges, with all three stories above the floor system, is braced by using overhead-bracing supports with transoms and sway braces on the top chord of the upper story (fig 9–3) or by inverting the third story panels and placing transoms and sway braces in their normal seating in the inverted panels.

9–6. With Overhead-Bracing Supports

When overhead-bracing supports are used, they are placed one per girder on each bay of the bridge (fig 9–4). They are positioned on panels of the inner and second truss over the chord bolt holes nearest the female lugs. This provides clearance for the bracing frames on the top chord. Transoms are fastened to the tops of the supports and sway braces are pinned to the projecting ears on the supports. For a more detailed description of the overhead bracing support see paragraph 2–25.

9–7. Without Overhead-Bracing Supports

When overhead-bracing supports are not used, the panels of the third story must be inverted so that transoms and sway braces can be inserted (fig 9–5). Transoms are fitted on the transom seats beneath the upper chord of the top story, and are held in place by transom clamps. Sway braces are placed in the sway-brace holes in the sides of the upper chord of the third-story panels. One transom and two sway braces are used per bay.

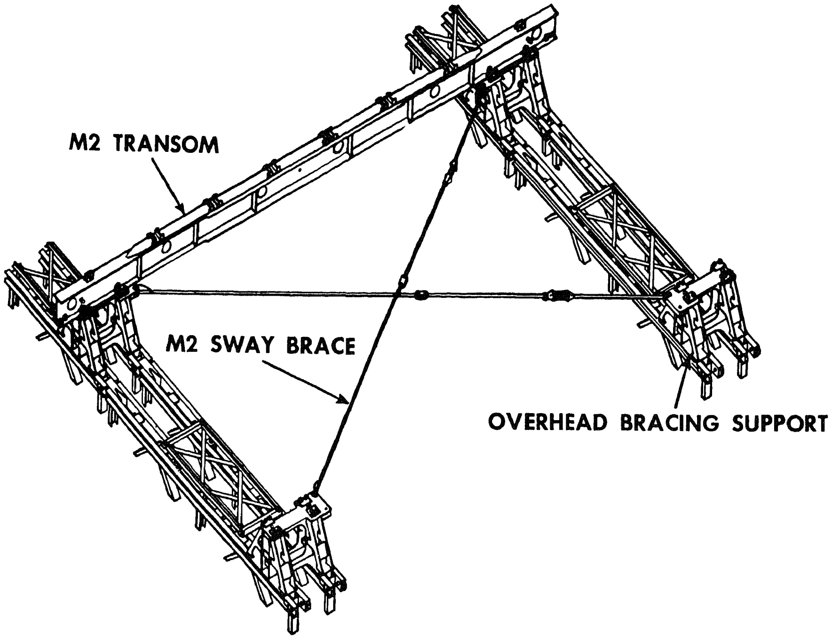


Figure 9–3. Location of bridge parts in overhead bracing of double-triple bridge.

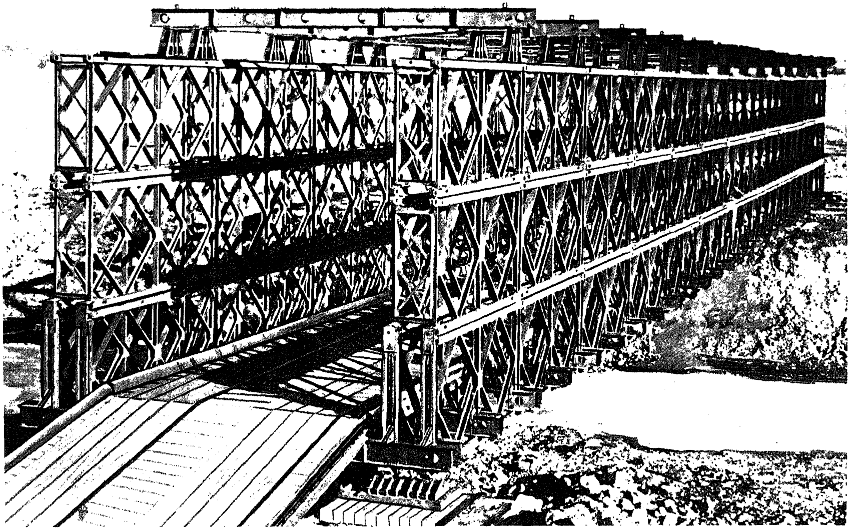


Figure 9–4. Overhead bracing on triple-story bridge using overhead-bracing supports.

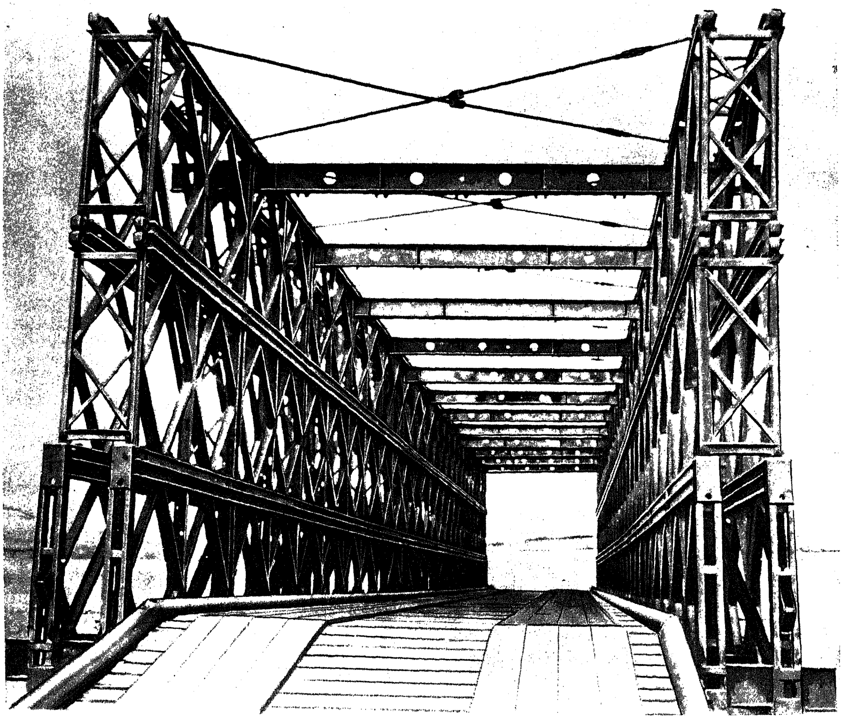


Figure 9–5. Overhead bracing on triple-story bridge with bracing in inverted third-story panels.

Double-triple bridges are normally assembled bay by bay on the rollers and launched complete. Some of the longer spans, however, must be launched incomplete to reduce the launching weight.

9–9. Bridge

a. First Bay of Bridge. When assembly of the nose is completed, assemble the first bay of the bridge as follows:

(1) Connect inner and outer truss panels to last bay of nose. Manhandle parts into place.

(2) Add transoms, bracing, and decking in the same way as for single-story bridges.

(3) Add panels to second and third story with cranes. Stock piles are located near cranes to facilitate handling. Bracing frames are placed on front and rear panel verticals in second and third story on top chord.

(4) Lift overhead-bracing supports with bridge only. Bolts on other side are left out because bolt holes may not line up when transom is placed on supports because girders tend to lean slightly toward center.

(5) Position overhead transom and fasten by the two clamps on each support.

(6) Insert jack between support that is not bolted and outer truss of bridge. Force girders out and insert two chord bolts in the support.

(7) Position overhead sway braces but do not tighten until overhead transom in next bay has been fixed.

b. Remainder of Bridge. The rest of the panels are placed with the cranes. A single-truss section of two panels is assembled on the ground. When the two-panel section is assembled, a sling is attached, and the section is lifted into place by the crane. Top panel pins are inserted first and bottom ones next. The transoms and deck are added while the rest of the stories are being assembled.

Section V. ASSEMBLY OF TRIPLE-TRIPLE BRIDGE

9–10. Need for Special Methods

Triple-triple assembly is not a type of assembly commonly used. Because high launching weight may cause failure of the rollers or of the lower chord of the bridge, special methods must be used for assembling TT bridges.

9–11. Methods of Assembly

a. Launched as Incomplete Triple-Triple-Bridge. To reduce launching weight and prevent overload of the rollers TT bridges can be launched incomplete using the assembly given in table 9–2. The bridge is assembled and launched as follows:

(1) Assemble nose and partial bridge *exactly* as shown in table 9–2 according to span and launch to far-bank rollers using normal methods of assembly and launching.

(2) Continue launching bridge over gap until near-bank rocking rollers are under last TT bay of bridge. Dismantle nose beyond far-bank rocking rollers (fig 9–6).

(3) Make end DT bay TT and add enough TT bays to obtain required bridge length (six TT bays maximum). This gives the required bridge length for all but the 210-foot span. Because of staggered assembly the end bay of the latter bridge must be left DT at this point. Decking in 180-foot and shorter spans can be continued to the end of the bridge (fig 9–6).

(4) Continue launching bridge until near-bank rocking rollers are again under last TT bay of bays added (fig 9–6).

(5) Add five bays of DS nose type asembly to the near-bank end of all bridges (fig 9–6). Add enough bays to 210-foot bridge to obtain required bridge length before adding this tail assembly.

(6) Launch bridge forward until the three DT bays at front of bridge are beyond far-bank rollers. Complete DT bays by converting to TT and adding transoms (fig 9–6).

(7) Pull bridge back to final position, remove DS tail, and complete assembly in usual manner (fig 9–6).

b. Launched as Triple-Double Bridge Using Temporary Launching Pier. A normal TD bridge is assembled and launched. At the same time a temporary launching pier is assembled from panel bridge parts. The pier can be offset from the center of the gap so the short span is not less than 60 percent of the long span. After the pier is completed a platform is placed on the top to carry jacks. When the TD bridge has been jacked down

onto bearings the jacks are inserted under the bridge at the pier and the bridge jacked up approximately horizontal. A truck crane is then used to place the third story panels and the overhead bracing. Jacking most of the sag out of the bridge makes it possible to place the third story panels. When a fixed pier cannot be used, a floating pier can be used. The pontons are partially filled with water to float the pier under the bridge and then the water is pumped out to raise the bridge. Information on pier reactions is given in chapter 16 and on panel crib piers in chapter 17.

9–12. Vertical Clearance

Figure 9–7 shows the critical vertical clearances for triple-story bridges. The vertical clearance in triple-story bridges is of prime importance when loaded tank transporters pass over them. This is especially true when expedient overhead bracing is used. Where vehicles limit the vertical clearance to single-story assembly at the deck level, underslung stories or deck type construction may be used to provide the required bridge class.

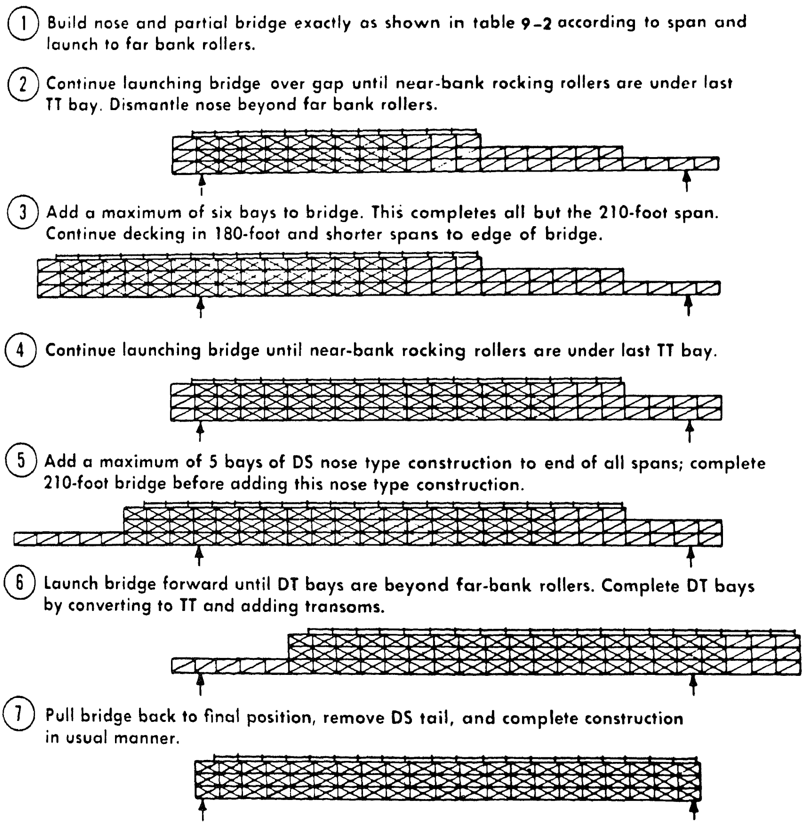
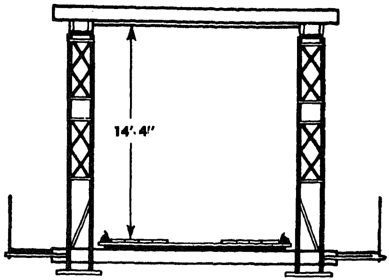
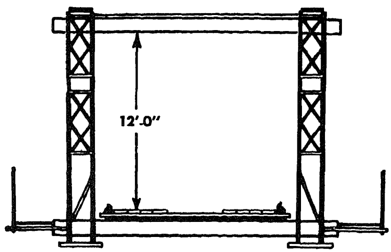


Figure 9–6. Assembly and launching of incomplete triple-triple bridge.



① TRIPLE-STORY WITH OVERHEAD BRACING



② TRIPLE-STORY WITH EXPEDIENT OVERHEAD BRACING

Figure 9–7. Triple-story bridges showing critical vertical clearance.

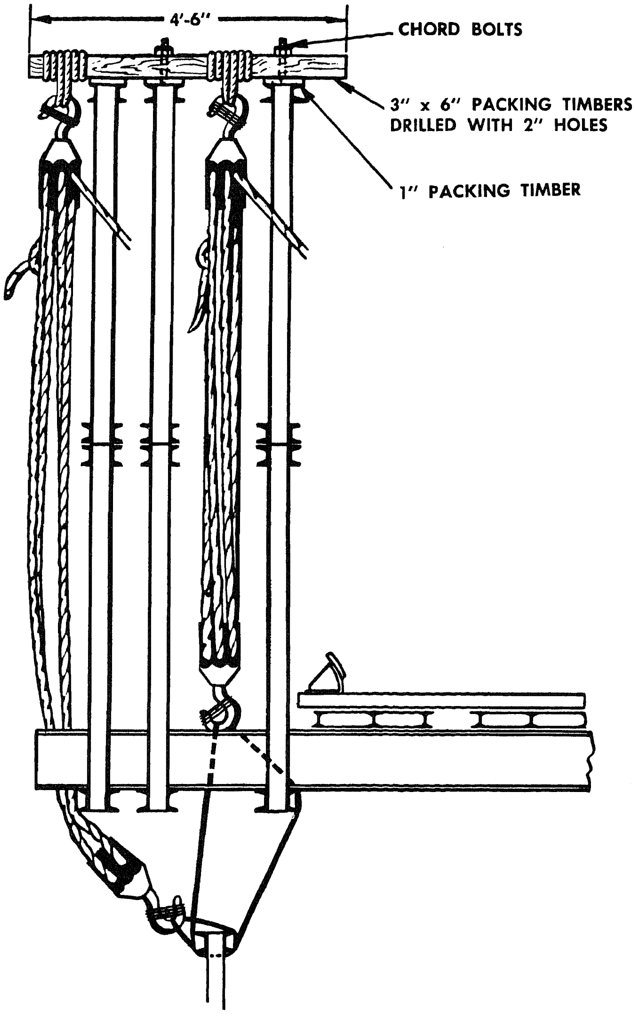


Figure 9–9. Positioning underslung single-truss girder using block and tackle.

CHAPTER 10

TWO-LANE THROUGH TYPE BRIDGE

10–1. Use

The two-lane through-type panel bridge is used to provide two-way traffic where—

a. Bridge supports at a demolished bridge are too narrow for two separate bridges (fig 10–1).

b. Narrow launching site necessitates lateral movement of separately launched bridges to position them on their bearings and, therefore, it would be easier to build a two-lane bridge.

10–2. General Description

a. Composition. The bridge consists of two independent outer girders and a common middle girder, assembled from standard panel bridge parts. The middle girder carries approximately half of the total load and must be about twice as strong as the outer girders. Transoms overlap and occupy alternate transom seatings on the middle girder.

b. Types of Assembly. Only the types of assem-

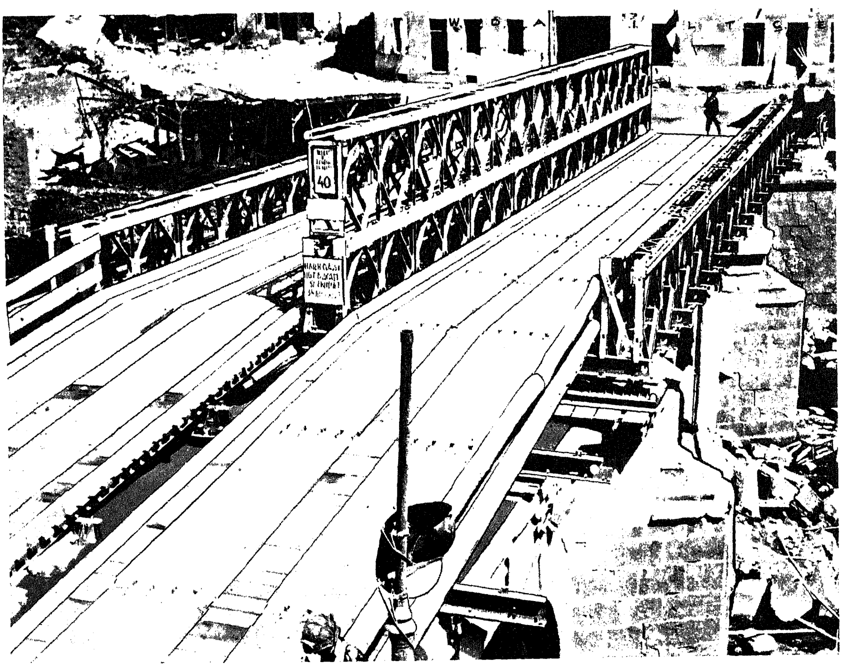


Figure 10–1. Two-lane panel bridge over demolished masonry arch bridge.

bly shown in figures 10–2 to 10–7 and listed in table 10–1 are used. Table 10–1 also gives maximum spans that can be assembled and launched with standard equipment. Longer spans can launched by using greased timbers or other ex dients (para 10–9).

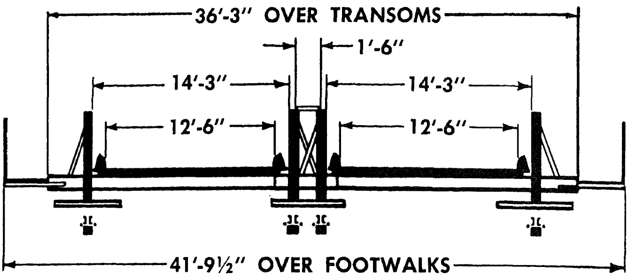


Figure 10–2. Single-single, double-single, two-lane bridge.

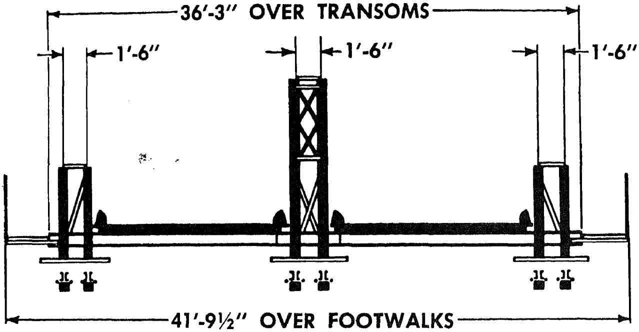


Figure 10–3. Double-single, double-double, two-lane bridge.

Table 10–1. Assembly, Maximum Span, and Weight per Bay of Two-Lane Panel Bridges

Type of construction		Abbreviation	Maximum span [1] (ft.)	Over-all width (ft.-in.)	Weight per bay (tons)
Outer girder	Middle girder				
		Bridge			
Single-single	Double-single	SS–DS	----------	36–3	
Double-single	Double-double	DS–DD	----------	36–3	
Triple-single	Triple-double	TS–TD	120	36–11½	
Triple-single	Quadruple-double	TS–QD	140	38–5½	
Double-double	Quadruple-double	DD–QD	160	38–5½	
Double-triple	Quadruple-triple	DT–QT[3]	160	38–5½	
		Nose			
Single-single	Single-single	SS–SS	----------	----------	
Single-single	Double-single	SS–DS	----------	----------	
Double-single	Quadruple-single	DS–QS	----------	----------	

[1] Limited by launching weight on rocking rollers.
[2] Fully decked and without footwalk and wear treads. Add .17 ton and .7 ton per bay for footwalks and wear treads respectively.
[3] Launched as double-story bridge.

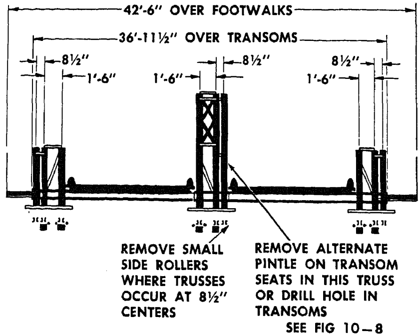


Figure 10-4. Triple-single, triple-double, two-lane bridge.

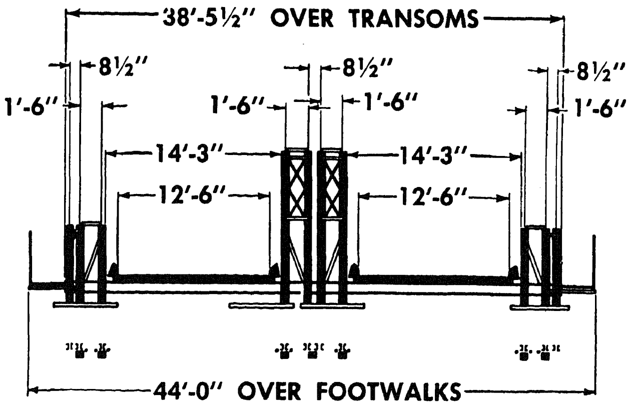


Figure 10-5. Triple-single, guadruple-double, two-lane bridge.

10-3. Class

The class and maximum spans of two-lane bridges are the same as those of single-lane bridges with the same truss assembly as the outer girders (table 10-2).

10-4. Limitations

Two-lane through type bridges have the following limitations:

a. The maximum span that can be launched by standard launching methods is 160 feet.

Table 10-2. Class and Launching Data for Two-Lane Bridges

(Located in Back of Manual)

bly shown in figures 10–2 to 10–7 and listed in table 10–1 are used. Table 10–1 also gives maximum spans that can be assembled and launched with standard equipment. Longer spans can be launched by using greased timbers or other expedients (para 10–9).

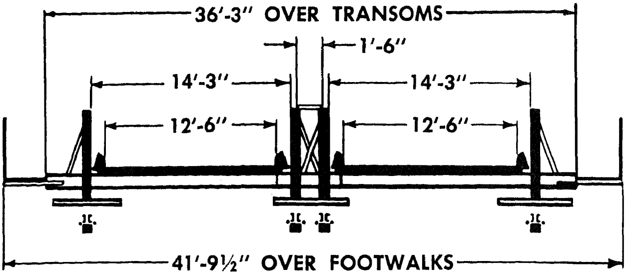


Figure 10–2. Single-single, double-single, two-lane bridge.

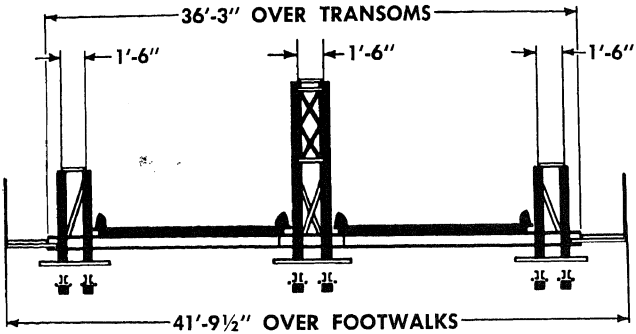


Figure 10–3. Double-single, double-double, two-lane bridge.

Table 10–1. Assembly, Maximum Span, and Weight per Bay of Two-Lane Panel Bridges

Type of construction		Abbreviation	Maximum span [1] (ft.)	Over-all width (ft.-in.)	Weight per bay[2] (tons)
Outer girder	Middle girder				
		Bridge			
Single-single	Double-single	SS–DS		36–3	5.5
Double-single	Double-double	DS–DD		36–3	6.8
Triple-single	Triple-double	TS–TD	120	36–11½	8.0
Triple-single	Quadruple-double	TS–QD	140	38–5½	8.7
Double-double	Quadruple-double	DD–QD	160	38–5½	9.3
Double-triple	Quadruple-triple	DT–QT[3]	160	38–5½	12.9
		Nose			
Single-single	Single-single	SS–SS			1.6
Single-single	Double-single	SS–DS			2.0
Double-single	Quadruple-single	DS–QS			3.3

[1] Limited by launching weight on rocking rollers.
[2] Fully decked and without footwalk and wear treads. Add .17 ton and .7 ton per bay for footwalks and wear treads respectively.
[3] Launched as double-story bridge.

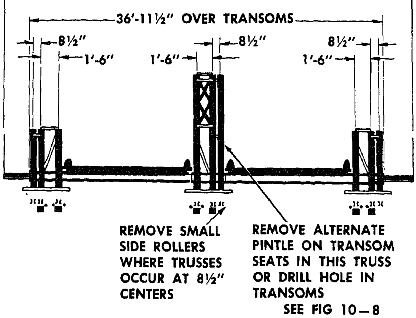


Figure 10–4. Triple-single, triple-double, two-lane bridge.

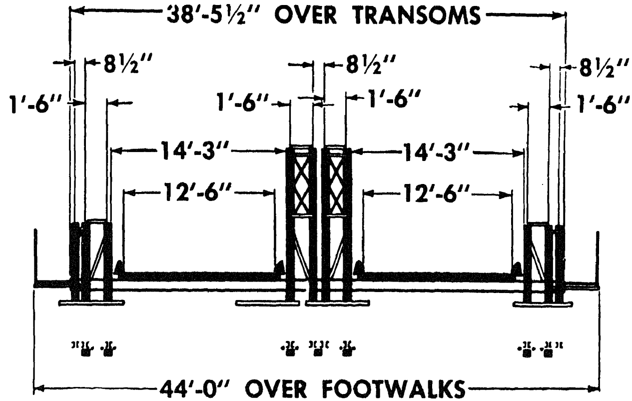


Figure 10–5. Triple-single, guadruple-double, two-lane bridge.

10–3. Class

The class and maximum spans of two-lane bridges are the same as those of single-lane bridges with the same truss assembly as the outer girders (table 10–2).

10–4. Limitations

Two-lane through type bridges have the following limitations:

a. The maximum span that can be launched by standard launching methods is 160 feet.

Table 10–2. Class and Launching Data for Two-Lane Bridges

(Located in Back of Manual)

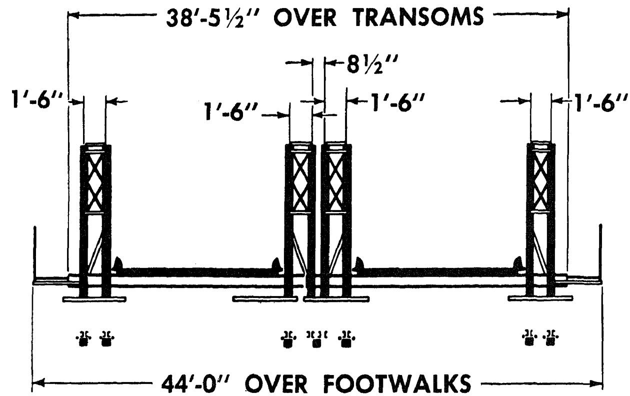


Figure 10–6. Double-double, quadruple-double, two-lane bridge.

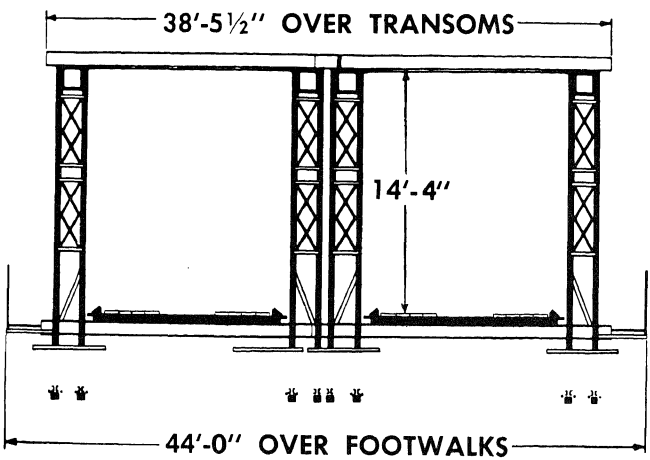


Figure 10–7. Double-triple, quadruple-triple, two-lane bridge.

b. Launching and jacking down are more difficult than for a single-lane bridge (para 10–9).

10–5. Number of Parts and Spares

Formulas for computing the number of parts and spares required to assemble the bridge and nose are given in table 10–3. The percentage of spares used for single lane bridges is also used for two-lane bridges (note 3, table 10–3).

10–6. Assembly Details

The following assembly details show how two-lane bridge assembly differs from single-lane assembly:

a. Transom Seating in TS–TD Bridges. The spacing of trusses in the girders of TS–TD bridges is normal with respect to one lane. With respect to the other lane, however, the two middle-girder trusses nearest that lane are spaced a

Bearing, footwalk	All types	4N+2	2 or 4		
Bearing	SS-DS	8			
	DS-DD	12			
	TS-TD	12			
	TS-QD	14			
	DD-QD	14			
	DT-QT	14			
Bolt bracing	SS-DS	12N+8	25%	6n+2	25%
	DS-DD	24N+12			
	TS-TD	30N+14		8n	
	TS-QD	36N+20			
	DD-QD	40N+24		8n	
				8n+36(140′)	
				8n+52(150′–160′)	
	DT-QT	56N+40			
Bolt, chord	DS-DD	4N	10%		
	TS-TD	6N			
	TS-QD	8N			
	DD-QD	16N			
	DT-QT	40N			
Bolt, end-post (spares)	All types		4		
Bolt, riband, guardrail or curb	All types		10%		
Bridge		16N			
Ramp		64			
Brace, sway					
w/o overhead bracing	All types	4N	10% to 4 max	SS–DS and DS–DD 2n; Rest 4n	1 or 2
w/overhead bracing	DT-QT	8N–4			
Chess	All types		10% to 20 max.		
Bridge		26N			
Ramp		104			
Clamp, transom	SS-DS	10N	10% to 20 max	4n+2	10%
	DS-DD	14N			
	TS-TD	21N		6n+3	
	TS-QD	22N		4n+2	
	DD-QD	18N		4n+2	
				4n+19(140′)	
				4n+25(150′–160′)	
	DT-QT	18N			
Footwalk	All types	2N	2		
Frame, bracing	SS-DS	N	10%		1 or 2
	DS-DD	4N+1			
	TS-TD	4N+1			
	TS-QD	6N+2			
	DD-QD	8N+4			
				9(140′)	
				13(150′–160′)	
	DT-QT	12N+8			
Panel	SS-DS	4N	10% to 10 max	3n	10%
	DS-DD	8N			
	TS-TD	12N		4n	
	TS-QD	14N			
	DD-QD	16N		4n	
				4n+8(140′)	
				4n+12(150′–160′)	
	DT-QT	24N			
Pedestal, ramp	All types	16			
Pin, panel	SS-DS	8N+8	20% to 50 max	6n–6	20%
	DS-DD	16N+12			
Pin, safety	TS-TD	24N+18	25% to 70 max	8n–8	25%
	TS-QD	28N+20			

See notes at end of table.

Table 10-3. Formulas for Computing Number of Parts and Spares for Two-Lane Bridges and Noses—Continued

Part	Bridge			None	
	Construction	Formula [1]	Spares [3]	Formula [2]	Spares [3]
	DD-QD	32N+16		8n-8	
				8n(140′)	
				8N+8(150′-160′)	
	DT-QT	48N			
Pin, sway-brace (spares)	All types		12		20% to 30%
Plate, base	SS-DS	6			
	DS-DD	6			
	TS-TD	6			
	TS-QD	8			
	DD-QD	8			
	DT-QT	8			
Plate, tie	TS-TD	4N+2	10%		
	TS-QD	2N+2			
Post, end, female	SS-DS	4	2		
Post, end, male	DS-DD	6	2		
	TS-TD	9			
	TS-QD	10			
	DD-QD	8			
	DT-QT	8	10% to 4 max.		
Post, footwalk	All types	4N+2	10%		
Raker	SS-DS	4N+4			
	DS-DD	4N+4		3n+1	2
	TS-TD	3N+3			
	TS-QD	4N+4			
	DD-QD	4N+4		4n	
	DT-QT	4N+4			
Ramp, button	All types	16			
Ramp, plain	All types	32			
Riband, guardrail or curb	All types				
Bridge		4N			
Ramp		16			
Stringer, button	All types	4N	10%		
Stringer, plain	All types	8N	10% to 4 max.		
Support, bracing, overhead	DT-QT	4N	10% to 4 max.		
Transom				SS-DS	
Bridge				DS-DD	
w/o overhead bracing	All types	4N+2	10% to 4 max.	TS-TD 2n+1	1
				TS-QD	
w/overhead bracing	DT-QT	6N+2		DD-QD 2n+1	
Ramp	All types	4		2n+2(140′-160′)	

[1] N=Number of bays in bridge.
[2] N=Number of bays in nose (see table 10-2).
[3] Spares are not included in formulas and must be added.

8½ inches instead of 1 foot 6 inches. Accordingly, transoms from that lane do not fit on seating pintles of the center truss; these pintles must be removed or transoms drilled (fig 10-8).

b. Ramp Clearance. To provide clearance between transoms and ramps at the ends of SS-DS and DS-DD bridges a 3½- by 4½-inch notch is cut in transoms seated on the end posts and the ramp transoms are offset 2¼ inches from the bridge centerline (fig 10-9).

c. Launching Nose. The number of bays and assembly of launching noses for two-lane bridges are given in table 10-2.

(1) *SS-DS and DS-DD bridges.* Noses for SS-DS and DS-DD bridges consist of three SS trusses. One completely braced nose of the required length is assembled for one lane. For the second lane, a single truss is added and connected to the middle truss by transoms overlapping the transoms of the first lane. Rakers are added to the second lane but sway bracing is omitted (fig 10-10).

(2) *TS-TD, TS-QD, and DD-QD bridges.* Noses for TS-TD, TS-QD and DD-QD bridges normally consist of SS outer girders and two SS middle girders (fig 10-11). However, all girders

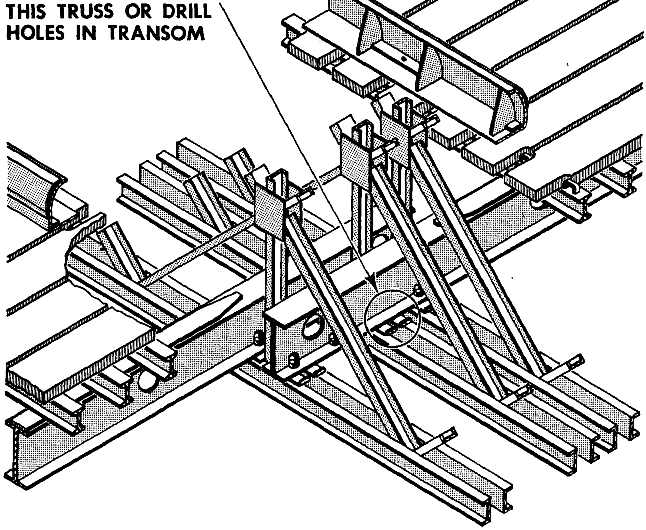


Figure 10–8. Transom seating in TS–TD bridges.

in the last two nose bays of the 140-foot DD–QD and the last three nose bays of the 150- and 160-foot DD–QD bridges are double-truss assembly. In all cases, transoms are placed in alternate seatings and the nose is braced the same as for normal assembly. Transoms connect the nose girders of the TS–TD bridge. However, the nose girders of the TS–QD and DD–QD bridges cannot be connected because transoms are not long enough except in DS–QS nose bays.

10–7. Working Parties and Assembly Time

a. Single-Lane Bridge Assembly Party. With the same party organization as for single-lane bridges, assembly time for a two-lane bridge is slightly more than double the assembly time for a single-lane bridge.

b. Special Organization. With a specially organized crew (table 10–4), assembly time for a two-lane bridge is slightly less than double the assembly time for a single-lane bridge.

c. Unloading and Security Details. Unloading and security details are the same as for a single-lane bridge.

10–8. Roller Layout

Figures 10–2 to 10–7 show lateral spacing of rocking rollers for various types of bridge assembly. Roller loads for outer girders are the same as for single-lane bridges. However, since roller loads for the middle girder are approximately double, enough plain rollers must be used under this girder to prevent overloading them. These plain rollers must be staggered to provide clearance between them (fig 10–12). Chapter 6 describes the method of using a transom to position bearings for rocking rollers. Rocking rollers are used on the far bank for all bridges except SS–DS, where plain oilers may be used.

10–9. Assembly and Launching

Methods of assembling and launching the two-lane bridge are the same for both the single-lane assembly party and the special organization given in table 10–4.

a. Assembling SS–DS and DS–DD Bridges.

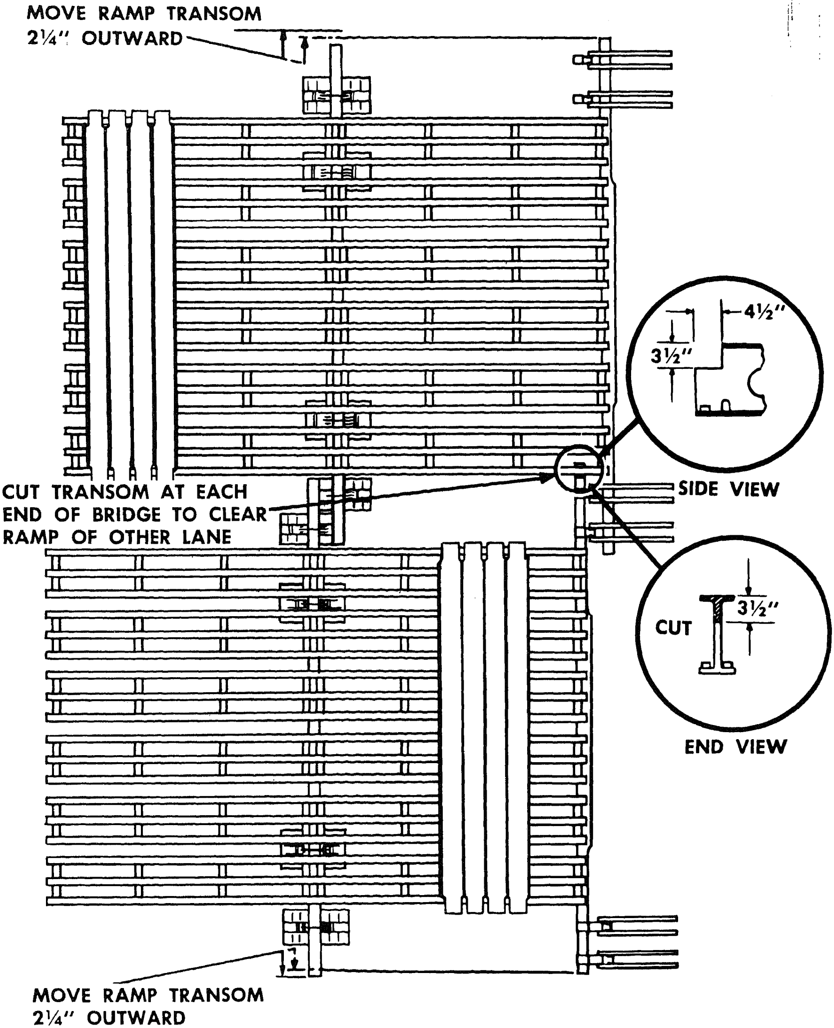


Figure 10–9. Ramp clearance for SS–DS and DS–DD bridges.

(1) Assemble one lane of launching nose with sway bracing in every bay, using launching links if necessary. Place one transom behind forward upright of panel in first bay and one transom in front of rear upright of panel at each joint. Fix rakers at each joint.

(2) Add third truss for other lane, using launching links if necessary. Place one transom for second lane of nose in front of middle upright of panel in first bay and one transom behind upright of panel at each joint. Fix rakers at each joint.

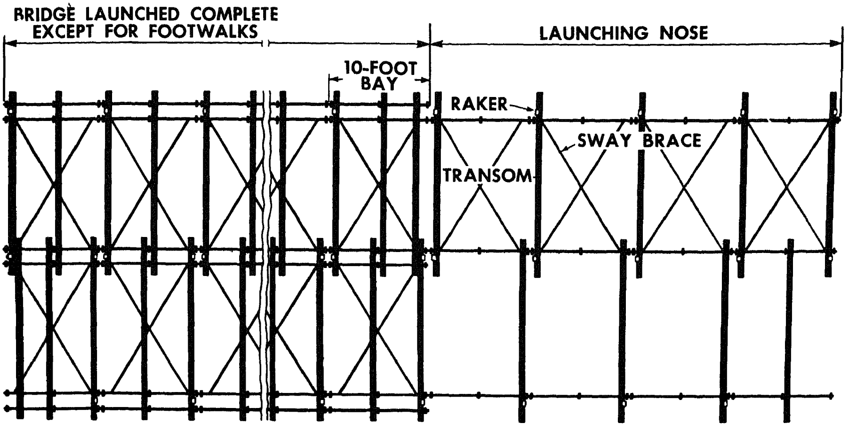


Figure 10–10. Typical launching nose for SS–DS and DS–DD bridges.

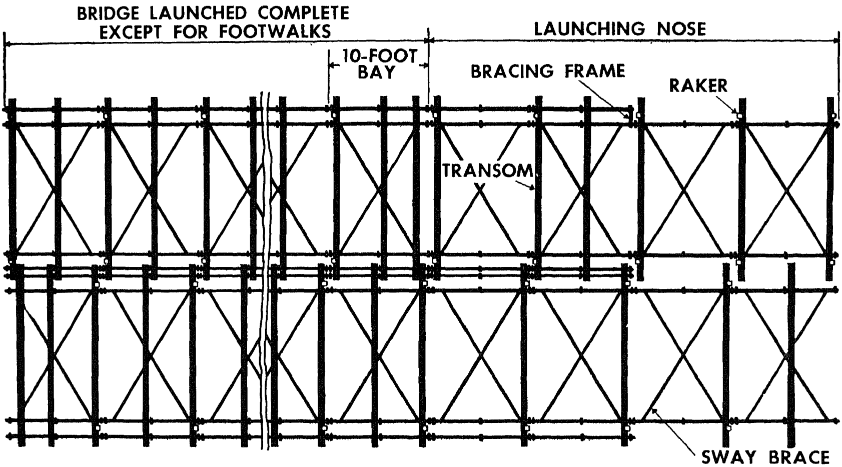


Figure 10–11. Typical launching nose for 140-, 150-, and 160-foot DD–QD bridges. Launching nose for TS–TD, TS–QD, and the remainder of DD–QD bridges is similar with extra transom and two bays of DS–QS assembly omitted.

(3) Assemble bridge the same as for single-lane bridge assembly keeping panels in one lane one bay ahead of panels in the other lane. Attach all bracing frames as for a single-lane bridge.

b. Assembling TS–TD, TS–QD, and DD–QD Bridges. Assemble bridge the same as for single-lane assembly, keeping panels in one lane one bay ahead of panels in other lane. For double- and triple-truss middle girders, attach bracing frames, tie plates, and rakers as in single-lane bridge assembly. When middle girder is quadruple-truss assembly, do not use tie plates between center trusses; use full number of bracing frames and rakers (fig 10–2 to 10–7).

Table 10–4. Suggested Organization of Assembly Parties—Two—Lane Bridge

Party	Number of NCO's and EM for various type bridges				
	SS–DS	DS–DD	TS–TD	TS–QD	DD–QD
Panel	2–28	2–28	2–48	2–54	3–64
Carry	(24)	(24)	(42)	(48)	(56)
Pin	(4)	(4)	(6)	(6)	(8)
Transom	2–18	2–18	2–20	2–20	2–20
Carry	(16)	(16)	(16)	(16)	(16)
Clamp	(2)	(2)	(4)	(4)	(4)
Bracing	2–14	2–18	2–21	2–26	2–28
Sway brace	(6)	(6)	(6)	(6)	(6)
Raker	(6)	(6)	(6)	(6)	(6)
Bracing frame	(2)	(4)	(4)	(8)	(10)
Chord bolt	-------	(2)	(2)	(4)	(6)
Tie plate	-------	-------	(3)	(2)	
Decking	2–20	2–20	2–20	2–20	2–20
Stringer	(12)	(12)	(12)	(12)	(12)
Chess and riband	(8)	(8)	(8)	(8)	(8)
Total	8–80	8–84	8–109	8–120	9–132

c. Assembling DT–QT Bridge. Assemble the DT–QT bridge the same way as the DD–QD bridge. However, when using overhead bracing supports in both lanes, make sure female panel lugs in one lane face in opposite direction to female lugs in other lane. This prevents interference between overlapping transoms.

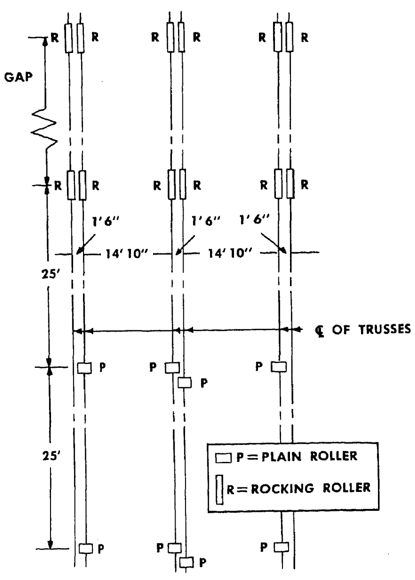


Figure 10–12. Typical roller layout showing plain rollers staggered under middle girder.

d. Launching. Table 10–2 gives the launching weight for each type of assembly. The lighter bridges listed in the table can be launched by single-lane launching methods. For heavier bridges, vehicles with winches can be used to aid in launching. Care must be taken to prevent overloading of rollers to keep the balance point of bridge and nose behind the near-shore rocking rollers. Spans longer than those listed in table 10–1 can be launched by—

(1) Skidding the bridge over greased timbers to give more bearing along the lower chord of the girders. The bridge load, however, must not exceed the crushing strength of the timber.

(2) Launching the bridge in skeleton form so the allowable load on the rollers is not exceeded.

(3) Using special rocking distributing beam for mounting two rocking rollers in line under each truss.

e. Jacking.

(1) *Single-span two-lane bridges.* Jacking of single-span two-lane bridges is done the same way as for single-lane bridges.

(2) *Bridges on piers.* See chapter 16. Tables 10–5 and 10–6 give maximum lengths of adjacent spans of continuous-span two-lane bridges that can be jacked over intermediate piers with jacks arranged as shown in figures 16–19 and 16–20.

10–10. Reinforced Two-Lane Bridges

Two-lane bridges are reinforced by adding trusse or stories using the same methods as for single lane bridges (para 7–14, 7–16, 8–13, and 8–14) Normally, reinforcement for only one lane is nec essary. For capacity greater than class 70 th floor system must be reinforced by using fou transoms per bay instead of two and by addin longitudinal wear treads.

a. Truss Assembly. Table 10–7 gives the trus assembly of reinforced two-lane bridges.

b. Methods of Reinforcing. Stories can be adde to the top of the existing girders or they can b underslung. However, when the middle girder reinforced to triple-story, the panels must be un derslung unless the reinforced outer girder is als triple-story; otherwise, overhead bracing cann be installed.

(1) *Reinforcing one outer girder.* One lane a two-lane bridge can be reinforced by reinforcin one outer girder. However, the reinforced la

Table 10-5. Maximum Length of Continuous-Span Two-Lane Bridge That can be Jacked Over Intermediate Pier, With Jacks Arranged as in Figure 16-19 [1]

Construction of span	Maximum lengths of two spans of continuous bridge over intermediate piers [1]							
		Two jacks under trusses at center and each side of bridge			Four jacks under trusses at center and each side of bridge			
SS DS	Short span	0–35	40–55	57.5	0–45	50–80		
	Long span	(2)	60	57.5	(2)	80		
DS–DD	Short span	0–40	45–50	55–65	0–70	75–120		
	Long span	(2)	70	65	(2)	120		
TS–TD	Short span				0–70	75–85	90–100	105–110
	Long span				(2)	120	115	110
TS–QD	Short span				0–60	65–80	85–95	97.5
	Long span				(2)	105	100	97.5
DD–QD	Short span				0–65	70–85	90–100	102.5
	Long span				(2)	110	105	102.5

[1] Based on dead weight of two spans of same construction over intermediate pier.
[2] Length of long span cannot exceed 167% of short span.

Table 10-6. Maximum Length of Continuous-Span Two-Lane Bridge That can be Jacked Over Intermediate Pier, With Jacks Arranged as in Figure 16-20 [1]

Construction of span	Maximum lengths of two spans of continuous bridge over intermediate piers [1]								
		Six jacks under trusses at center and each side of bridge				Twelve jacks under trusses at center and each side of bridge			
SS–DS	Short span	0–45	50–80			0–45	50–80		
	Long span	(2)	80			(2)	80		
DS–DD	Short span	0–60	65–80	85–95	97.5	0–70	75–120		
	Long Span	(2)	105	100	97.5	(2)	120		
TS–TD	Short span	0–50	55–65	70–80	82.5	0–80	85–140		
	Long span	(2)	90	85	82.5	(2)	140		
TS–QD	Short span					0–70	75–85	90–100	105–115
	Long span					(2)	125	120	115
DD–QD	Short span					0–75	80–90	95–105	110–120
	Long span					(2)	130	125	120

[1] Based on dead weight of two spans of same construction over intermediate pier.
[2] Length of long span cannot exceed 167% of short span.

Table 10-7. Equivalent Simple Span Assembly for Reinforced Lane of a Two-Lane Bridge

Existing bridge	Method of reinforcing		Equivalent reinforced lane construction	
	Outer girder	Middle girder	Normal lane closed to traffic	Both lanes open to traffic
SS–DS	Add one truss		DS	SS
	Add one truss	Add double truss second story	DS	DS
DS–DD	Add double truss second story		DD	DS
	Add double truss second story	Undersling double truss third story	DD	DD
TS–TD	Add triple truss second story		TD	TS
	Add triple truss second story	Undersling triple truss third story	TD	TD
TS–QD	Add double truss second story		DD	DD
	Add double truss second and third story and overhead bracing.	Add double truss third story and overhead bracing.	DT	DT
DD–QD	Add double truss third story and overhead bracing.	Add double truss third story and overhead bracing.	DT	DT

has the capacity of a single-lane bridge of the same assembly as the reinforced outer girder only when the normal lane is closed to traffic.

(2) *Reinforcing one outer girder and middle girder*. When both the outer and middle girders are reinforced, the reinforced lane has the same capacity as a single-lane bridge of the same assembly as the reinforced outer girder without closing the normal lane to traffic.

10–11. Conversion of Single-Lane Bridges to Two-Lane Bridges

To convert a single-lane bridge to a two-lane bridge without closing the bridge to traffic for a long period, take the following steps:

a. If two-lane bridge is to be centered on old bridge centerline, proceed as follows:

(1) Remove approach ramps on each bank and jack bridge up. Lay transom on three plain rollers on each bank perpendicular to bridge centerline, so raker lugs come directly under spaces between girders of end bays. Extra bays are added to the bridge where insufficient working space on bank is available before transoms are placed.

(2) Prepare new bank seats and position grillage. Center grillage must be twice the width of the outer grillage.

(3) Jack bridge down on the transoms resting on the rollers and move bridge sideways to new position.

(4) Position bearings for the bridge in its new location. Bearings are placed under original end span or extra span depending on bank conditions. Jack bridge onto bearings.

(5) Place ramps and open single lane of bridge to traffic (fig 10–13).

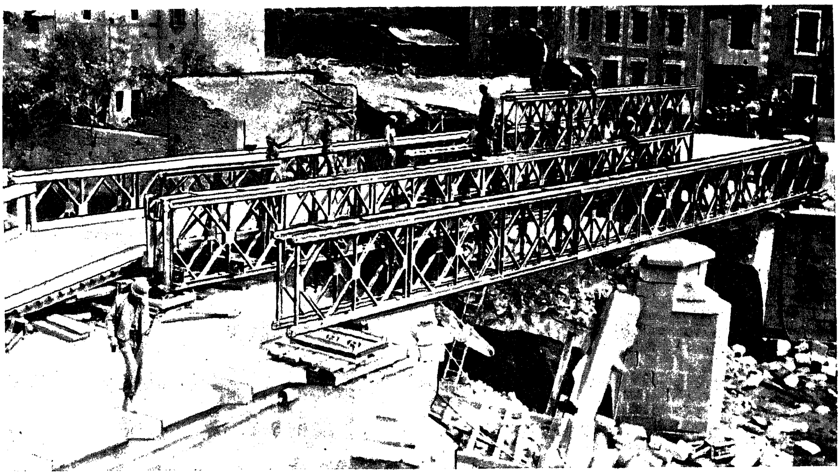


Figure 10–13. Converting single-lane bridge to two-lane bridge using single-girder method for launching outer girder in second lane. Note single lane open to traffic during construction.

(6) Position rollers for third girder and launch by single-girder method (fig 10–13). See chapter 19 for launching by single-girders. The third girder can also be launched by using a truck crane on deck of existing bridge.

(7) Connect third girder to rest of bridge with transoms. If available, use a truck crane to place transoms. If a truck crane is not available or if sag is great, add second story to middle girder before connecting third girder with transoms.

(8) Add second story to middle girder.

(9) Deck second lane.

b. If existing bridge is to remain in position, proceed as follows:

(1) Jack bridge up and double grillage area under center girder. Jack bridge down. If bridge is to be lengthened, add extra bays and locate bearings and grillage in new position.

(2) Proceed as for two-lane bridge (*a* above).

CHAPTER 11

EXTRA WIDENED BAILEY BRIDGE, M3

Section I. GENERAL INFORMATION

11–1. Purpose of Bridge

The introduction of wider vehicles prompted the development of the extra widened Bailey bridge M3. The US Army does not stock the M3 Bailey bridge. It is a standard bridge in the United Kingdom.

11–2. General Description

The extra widened Bailey bridge M3 has a 13-foot 11¾-inch clear roadway and a clear distance between trusses of 15 feet 8½-inches as shown in figure 11–1. This additional width requires certain new parts that are not contained in the M2 bridge set. The most important of these are a long transom, additional stringers, long chess, sway braces, and bracing frames.

11–3. Classes

The bridge normally is assembled for either class 30 or class 80 loads. The maximum spans for each type of assembly at these classes are given in table 11–1.

Table 11–1. Maximum Class of Vehicle for Safe Crossing Over Extra Widened Bailey Bridge M3

Bridge class	Type of construction	SS	DS	TS	DD	TD	DT	TT	Transoms per bay
30	Maximum simple span (ft)	40	80	110	130	150	180	200	
	Maximum wheeled vehicle class	22*	31	30	30	30	32	31	2
	Maximum tracked vehicle class	23*	33	33	34	33	36	33	2
80	Maximum simple span (ft)		40	60	80	110	110	120	
	Maximum wheeled vehicle class		70*	87*	95*	78	73*	93*	4
	Maximum tracked vehicle class		66*	80*	93*	80	75*	96*	4

* Indicates shear governs; otherwise moment governs.

11–4. Weights

The weight in tons per typical bay for each type of assembly, class, and span is given in table 11–2.

Table 11–2. Weight of Typical Bays for Extra Widened Bailey Bridge M3

Bridge class		30 2 Transoms per bay	80 4 Transoms per bay
Type of construction	Typical bays	Weight per bay (short tons)	Weight per bay (short tons)
SS	Tail	4.04	
	Intermediate	3.45	
	Head	4.73	
DS	Tail	4.90	6.01
	Intermediate	4.09	4.76
	Head	5.57	5.93
TS	Tail	5.62	6.76

Table 11–2. Weight of Typical Bays for Extra Widened Bailey Bridge M3—Continued

	Intermediate	4.72	5.39
	Head	6.33	6.69
DD	Tail	6.16	7.27
	Intermediate	5.35	6.01
	Head	6.86	7.22
TD	Tail	7.50	8.63
	Intermediate	6.58	7.25
	Head	8.22	8.58
DT	Tail	6.16	7.27
	Intermediate	7.18	7.85
	Head	6.91	7.27
TT	Tail	7.50	8.63
	Intermediate	9.02	9.69
	Head	8.27	8.63

Roadway width is 167¾ inches.
Weight of footwalks and ramps not included.

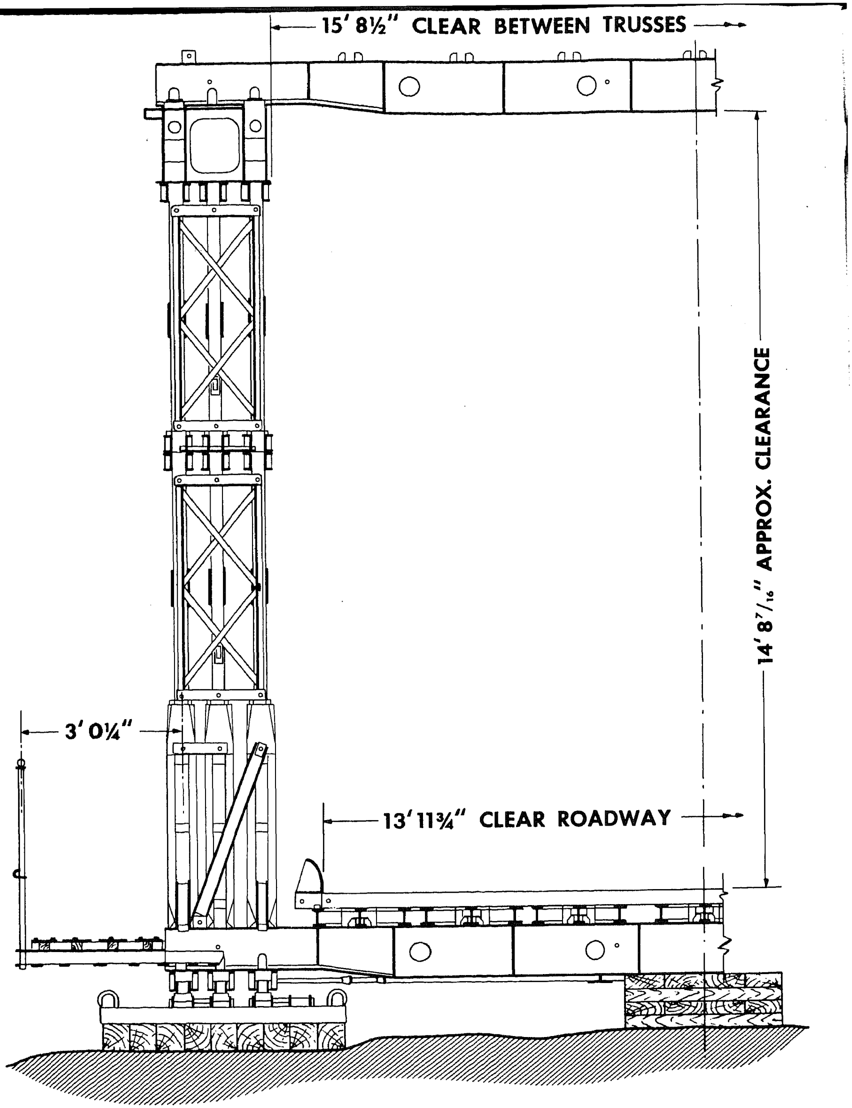


Figure 11-1. Cross section of extra widened Bailey bridge M3.

Section II. COMPONENT PARTS

11–5. Parts Described

The bridge parts which differ from those contained in the bridge set for the Bailey bridge M2 are described in paragraphs 11–6 through 11–18.

11–6. Transom

The transom is a 12-inch I-beam, 19 feet 11 inches long, tapered at the ends to 10 inches as shown in figure 11–2. Two transoms per bay are used for class 30 bridges and four transoms per bay are used for class 80.

11–7. Chess

The chess are 15 feet long, 8¾-inches wide, and 3⅝-inches deep. Thirteen chess are required for each bay of the bridge except the head bay which requires fourteen. The latter is for class 80 only.

11–8. Stringers

The plain and button stringers are the same as those used in the M2 bridge, except that the length of the head bay for class 80 bridges requires two long button stringers, M3, and two plain stringers, M3. These stringers are 10 feet 11½ inches long. They are used in the class 80 bridge only and not in the class 30 bridge.

11–9. Transom Clamp

The transom clamp, M3, is the same as that used

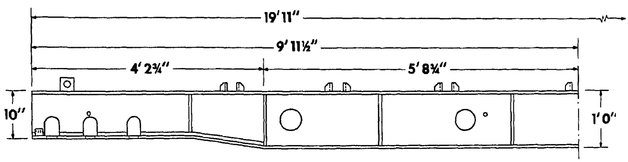


Figure 11–2. Transom, M3.

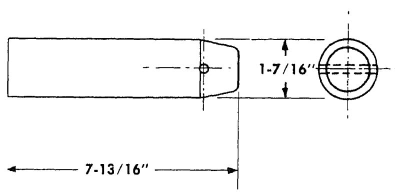


Figure 11–3. Headless panel pins, M3.

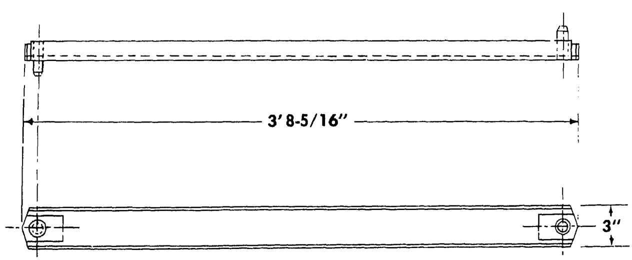


Figure 11–4. Raker, M3.

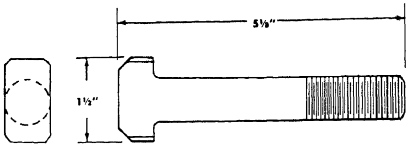


Figure 11–5. Riband bolt, M3.

in the M2 bridge except that the width across the top has been reduced slightly to prevent the arm from interfering with the vertical bracing frame used in the bottom story of triple truss bridges.

11–10. Riband

The ribands are the same as those in the M2 bridge, except that two long ribands, M3, are required in the head bay of the class 80 bridge. These are 10 feet 11¼ inches long.

11–11. End Posts

The male and female end posts are the same as those used in the M2 bridge except that in triple truss bridges the male end posts for the middle truss of both class 30 and class 80 bridges have the transom bracket removed. This permits rakers to be connected between the end posts on the inner trusses and the transom. Female end posts, M3, are used on the middle truss of the end bay of class 80 bridges only.

11–12. Panel Pin, Headless

Headless panel pins are used on triple truss assembly to connect the end posts, M3, to the middle trusses. They are necessary to enable the end posts to be fitted after the launching nose has been removed and to allow damaged end posts to be replaced. These panel pins, M3, are similar to those in the M2 bridge except the head is removed (fig. 11–3).

11–13. Raker

A new type raker, M3, has been developed for use with the extra widened Bailey bridge, M3. It is a 3-inch channel 3 feet 8-5/16 inches long, as shown in figure 11–4.

11–14. Riband Bolt

A riband bolt, M3, is used as shown in figure 11–5.

11–15. Bracing Frame

The bracing frame, M3, has an additional pair of dowels, as shown in figure 11–6, to accommodate the bracing bolts connecting it to the middle truss of a triple truss bridge.

11–16. Sway Brace, M3

The sway brace, M3, is similar to that in the M2 bridge, but is 18 feet ⅛ inch between centers of eyes with the turnbuckle screwed tight.

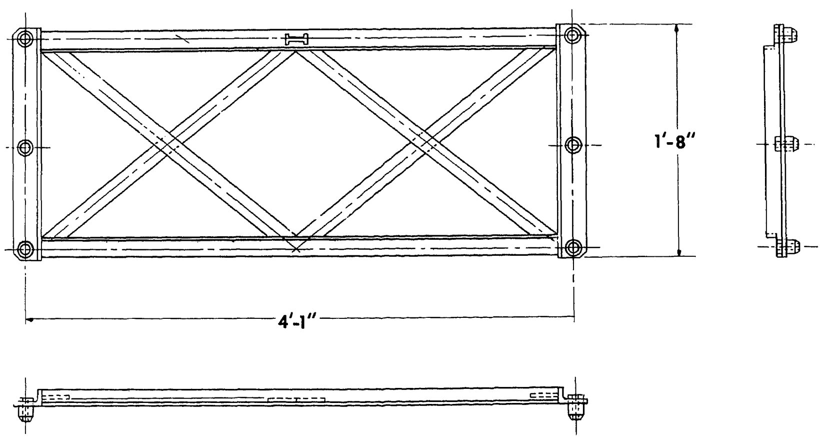


Figure 11–6. Bracing frame, M3.

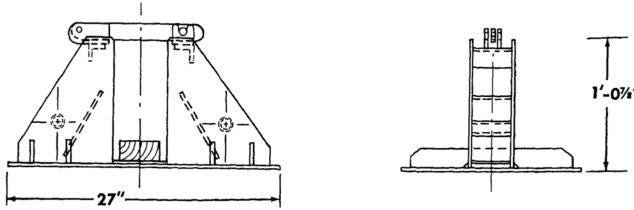


Figure 11–7. Ramp pedestal, M3.

11–17. Overhead Sway Brace Extension, M3

The overhead sway brace extension has an eye at one end and a jaw at the other and is connected to the sway brace, M3, for use in the overhead bracing of intermediate bays of triple story bridges.

11–18. Ramp Pedestal, M3

The ramp pedestal, M3, is used to support the deeper (12-inch) portion of the M3 transom. It is similar to the pedestal used in the M2 bridge, but is deeper and has a wider space for the transom (fig 11–7).

Section III. ASSEMBLY AND LAUNCHING OF SINGLE-STORY BRIDGES

11–19. Method

a. The method of assembling single story bridges is the same as that for the M2 bridge with the exception of roller layout, launching nose, triple truss assembly, and class 80 decking.

b. The number of parts required per bay is given in tables 11–6 and 11–7 for class 30 and class 80 bridges.

11–20. Roller Layout

a. The lateral spacing of rollers is shown in figure 11–8. The rollers must be staggered for triple truss assembly.

b. There is no suitable bridge part to use as a distance gage, and the roller templates must be positioned by means of a steel tape or improvised gage.

c. For 30- and 40-foot bridges, a plain roller must be placed 15 feet from the rocking roller. On longer spans, plain rollers are spaced at 27 feet and up, in increments of 25 feet; consequently, the longitudinal spacing of plain rollers is normally at 27, 52, 77, etc. feet.

11–21. Launching Nose

a. Information on launching weights and launching nose assemblies for various type bridges is given in tables 11–3 and 11–4.

b. Due to the greater width of the bridge, it is necessary to have one transom with two rakers in each bay of the nose, and also sway braces in each bay.

11–22. Triple-Single Assembly

a. Method. After assembly of the skeleton launching nose, the bridge trusses are assembled in echelon, with each outer truss always having one panel more than the adjacent truss. It is not possible to add a third truss to a double truss bridge.

b. First Bay of Bridge.

(1) Connect the first two inner truss panels to the inner trusses of the launching nose, driving the panel pins outward.

(2) Place a transom through these panels in front of the center vertical, and connect the long arms of the sway braces to the front ends of the panels.

(3) Assemble two panels for the middle trusses, and connect them to the transom clamps.

(4) Assemble two panels for the outer trusses, and connect them to the transom clamps.

(5) Pass a second transom through all three trusses of the first bay behind the front vertical, and a third transom in front of the rear vertical. Connect the panels to the transom with transom clamps.

(6) Connect the short arms of the sway braces to the rear position, and fit bracing frames in the first bay on the top chords.

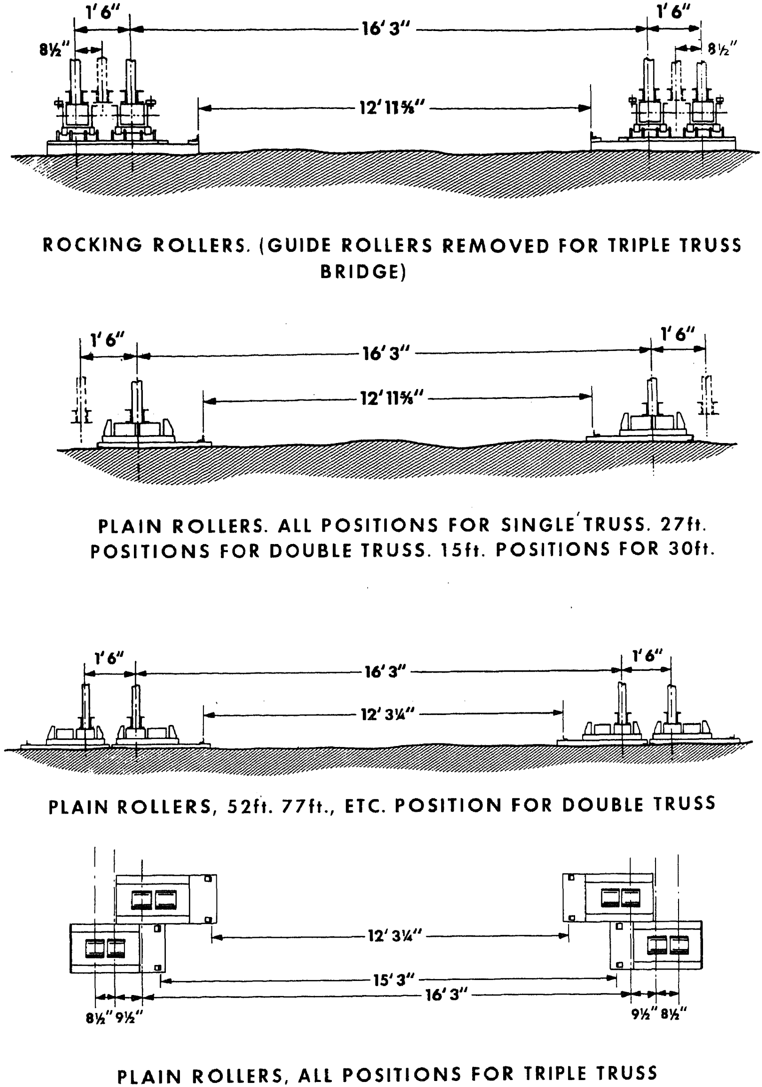


Figure 11–8. Roller layout.

(7) Fit bracing frames in front of the front verticals and behind the rear verticals. The front bracing frames are removed before the end posts are fitted.

(8) Tighten transom clamps and braces. Place stringers and decking.

c. Second Bay of Bridge.

(1) Place two panels for the outer tr

Table 11–3. Launching Data for Class 30 Spans

Span	Assembly	Bays in nose		Launching wt (tons)	Sag (inches)	d [1]	Bridge launched without:
		SS	DS				
30	SS	2	-----------	10.0	1½	19′–6″	
40	SS	3	-----------	13.6	2½	26′–11″	
50	SS	3	-----------	16.3	4	31′–8″	
60	DS	4	-----------	23.4	5	37′–8″	
70	DS	5	-----------	27.6	9	44′–9″	
80	DS	5	-----------	30.9	13	49′–6″	
90	TS	6	-----------	40.1	15	55′–2″	
100	TS	7	-----------	44.9	20	61′–11″	
110	TS	7	-----------	48.8	26	66′–8″	
120	DS	7	1	60.6	21	72′–6″	
130	DD	7	2	66.4	26	79′–8″	
140	TD	6	3	81.7	26	81′–7″	All footwalks and first four bays, chesses and ribands.
150	TD	7	3	83.1	35	87′–8″	All footwalks and first ten bays, chesses and ribands.
160	DT [2]	7	4	80.9	36	99′–4″	All footwalks, decking and stringers.
170	DT [2]	7	4	82.2	42	102′–3″	All footwalks, decking, stringers, and first three bays in top story.

[1] d is the distance from the center of gravity to the tail of the bridge.
[2] Launched with overhead bracing and first and last bays double story only.

Notes.
(1) Bridge launched complete with decking and footwalks, except where shown. Parts left off bridge are to reduce launching weight and launching stresses.
(2) Rocking rollers 3′ 6″ in front of baseplate on each bank. (Minimum: 2′ 6″).
(3) For 30- and 40-ft. spans, plain rollers are required 15 ft. from launching rollers.
(4) Sag given is at tip of launching nose in worst case.
(5) All bracing frames must be fixed and tightened before launching, including frames on DS nose.
(6) Launching links may be used not more than—
40 ft. back from end of SS portion of nose.
20 ft. back from end of DS portion of nose.

Table 11–4. Launching Data for Class 80 Spans

Span	Assembly	Bays in nose		Launching wt (tons)	Sag (inches)	d [1]	Bridge launched without:
		SS	DS				
30	DS	2	-----------	13.5	1½	18′–4″	
40	DS	3	-----------	18.3	2	25′–2″	
50	DS	3	-----------	22.2	3½	30′–11″	
50	TS	3	-----------	25.0	3½	29′–4″	
60	TS	4	-----------	30.3	5	36′–0″	
70	TS	5	-----------	35.7	6	42′–7″	
70	DD	5	-----------	39.4	5½	41′–10″	
80	DD	5	-----------	44.4	7	46′–7″	
90	TD	5	1	60.8	9	52′–2″	
100	TD	6	1	67.8	12	58′–5″	
110	TD	6	1	73.9	14	63′–3″	
110	DT [2]	5	2	77.0	12	63′–4″	
120	TT [2]	5	3	83.2	15	69′–0″	All footwalks, decking, and stringers and first two bays top story.
130	TT	5	3	83.4	20	72′–1″	All footwalks, decking, and stringers and first five bays top story.

[1] d is the distance from the center of gravity to the tail of the bridge.
[2] Launched with overhead bracing and first and last bays double story only.

Notes.
(1) Bridge launched complete with decking and footwalks, except where shown.
(2) Rocking rollers 3′ 6″ in front of baseplate on each bank. (Minimum: 2′ 6″). Two rocking rollers required under each side where double or triple truss, including far bank for launching nose.
(3) For 30- and 40-ft. spans, plain rollers are required 15 ft. from launching rollers. In other cases, plain-roller positions are 27 ft., 52 ft., 77 ft., and 127 ft. from launching rollers, as necessary.
(4) Sag given is at tip of launching nose in worst case.
(5) All bracing frames must be fixed and tightened before launching, including frames on DS nose.
(6) Launching links may be used not more than—
40 ft. back from end of SS portion of nose.
20 ft. back from end of DS portion of nose.

and connect them with pins driven inwards. All further pins on all trusses are driven outward.

(2) Place two panels for the outer trusses of the third bay, and connect them with pins driven outward.

(3) Place two panels for the middle trusses in the second bay using headless panel pins.

(4) Two additional panels are now connected in bays four, three, and two, with the panel pins driven outward.

(5) Fit front end of sway brace in the second bay.

(6) Pass a transom through all trusses in the second bay in front of the rear vertical, and another in front of the center vertical. Connect them with transom clamps.

(7) Connect the sway braces to the rear positions.

(8) Fit the bracing frames on the top chords, and behind the rear verticals of the second bay.

(9) Tighten transom clamps and sway braces.

d. Subsequent Bays. The sequence of assembly for subsequent bays is similar to that described in c(4), (5), (6), (7), (8), and (9) above making sure that each truss in each outer bay has one more panel than the truss in the next inner bay.

e. Decking. The placing of stringers and chess follows the same sequence as in the M2 bridge, except for the number of stringers in all bays, and the number of chess in the head bay.

11–23. Class 80 Decking

a. The assembly procedure given in paragraph 11–22 is based on class 30 decking. For class 80, four transoms are required per bay, and in both double and triple truss bridges the extra two transoms are added behind the center and front verticals.

b. Transom clamps on the center vertical must be fitted alternately. For example, the front transom is clamped to the panel in the second truss, and the rear transom to the panels in the first and third trusses.

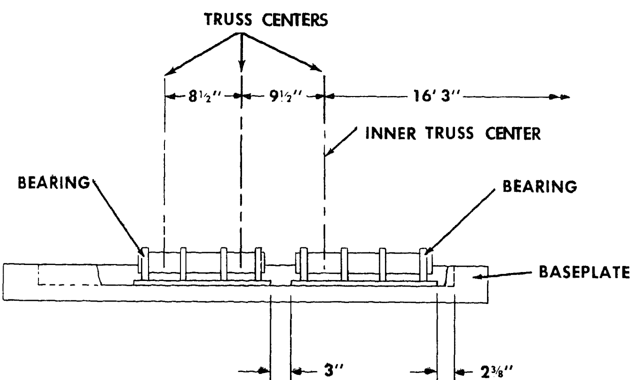
c. The stringers continue to the transoms on the end posts at each end. This makes the head bay of decking an 11-foot bay. In order to accomplish this, the first bay of stringers is laid with two button stringers, M3, on the outside, then two plain stringers, M2, inside these, and two plain stringers, M3, inside again, and one plain stringer, M2, in the center. In the last bay three plain stringers, M3, are used, and in all other bays plain and button stringers, M2, are used.

d. In the first bay fourteen chess and ribands, M3, are used. M2 ribands and thirteen chess are used in other bays.

11–24. End of Bridge

The end posts, bearings, and base plates are placed in the same way as the M2 bridge for single and double truss bridges. Triple truss bridges require the following changes.

a. Bearings and Base Plates. The base plates are placed as for double truss bridges. The outer bearing carries the end posts of the second and third trusses on the two seatings each side of the center seating. The inner bearing carries the end



M3, fitted at each end and headless panel pins are used.

is not possible to fit rakers at the tail end of the bridge because there is no transom on the end posts.

Section IV. ASSEMBLY AND LAUNCHING OF DOUBLE-STORY BRIDGES

11–25. Method

The method of assembling and launching double-story bridges is the same as that for the M2 bridge, except for the differences given in the following paragraphs, and the necessity of assembling the lower story as given in paragraphs 11–19 through 11–24.

11–26. Rollers

In addition to the pair of plain rollers which is required each side of the bridge 50 feet behind the launching rollers, a pair is required 75 feet behind the launching rollers. For bridges over 140 feet double rollers are required at 100 feet, and for the class 30 bridge with a span of 200 feet an additional pair of plain rollers is required at 125 feet from the launching rollers.

11–27. Second Story, Triple Truss Bridge

a. The assembly is the same as that for the M2 bridge, but the sequence of adding panels must follow the procedure as given in paragraphs 11–22c(4), and 11–22*d*. It is not necessary to use headless pins, provided the order of assembly is as follows:

Bay No. 1—Outer panel
Bay No. 2—Outer panel
Bay No. 1—Second panel
Bay No. 3—Outer panel
Bay No. 2—Second panel
Bay No. 1—Inner panel
Bay No. 4—Outer panel
Bay No. 3—Second panel

b. Headless pins must be used on the end posts, M3, where they are connected to the lower chords of the second truss of the second story.

c. Tie plates are not required.

Section V. ASSEMBLY AND LAUNCHING OF TRIPLE-STORY BRIDGES

11–28. Method

The method of assembling triple story bridges is the same as that for the M2 bridge, except for those factors given in paragraphs 11–29 and 11–30.

11–29. Triple-Triple Bridge

a. The sequence of adding panels in the top story must follow the order given in paragraph 11–27, except that assembly begins in the second bay. There are no panels in the top story of the first and last bays. Similarly, the sequence for the lower story of a bridge with underslung bottom story must be the same.

b. For all class 30 bridges, the bridge is launched with the top story in place.

c. For the class 80 bridge with a span of 120 feet, it is possible to launch the bridge as double story and add the third story afterwards.

11–30. Overhead Bracing

The only difference from the assembly of the M2 bridge is that the overhead sway brace extensions are fitted to the sway braces before they are connected to the overhead bracing supports, which are reversed so that the sway-brace pinholes are on the outside of the girders.

Section VI. GRILLAGES AND RAMP SUPPORTS

11–31. Grillages

a. The same grillages as those for the M2 bridge can be used.

b. The maximum base plate reactions are given in table 11–5 and the maximum launching roller reactions can be obtained from the launching weights given in tables 11–3 and 11–4.

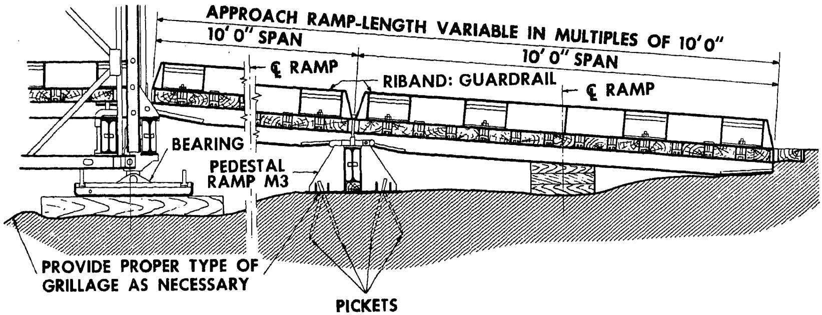


Figure 11–10. Ramp support for class 80 bridge.

Table 11–5. Maximum Reactions on any one Base Plate

Span	Maximum base plate reactions in tons for each span and assembly			
	Class 30		Class 80	
	Assembly	Reaction	Assembly	Reaction
30	SS	16.7	DS	32.5
40	SS	18.5	DS	36.1
50	SS	19.9	TS	38.7
60	DS	21.9	TS	41.6
70	DS	23.4	DD	44.5
80	DS	24.7	DD	46.4
90	TS	27.2	TD	51.1
100	TS	28.5	TD	53.7
110	TS	29.7	TD or DT	57.6
120	DD	32.5	TT	64.8
130	DD	34.2	TT	67.6
140	TD	40.4	TT	71.8
150	TD	42.8	TT	76.4

Table 11–5. Maximum Reaction on any one Base Plate—Continued

Span	Maximum base plate reactions in tons for each span and assembly			
	Class 30		Class 80	
	Assembly	Reaction	Assembly	Reaction
160	DT	47.2		
170	DT	49.6		
180	DT	52.1		
190	TT	62.3		
200	TT	65.3		

11–31. Ramp Supports

a. The end transoms of both class 30 and class 80 bridges must be supported at their midpoint.

b. For class 80 bridges the ramp must be supported as shown in figure 11–10.

Table 11–6. Number of Parts per Bay for Class 30 Bridges

Unit	Unit weight pounds	End bay at tail of bridge						
		S.S.	D.S.	T.S.	D.D.	T.D.	D.T.	T.T.
Plate: Base	381	2	2	2	2	2	2	2
Bearer: Footwalk	22	4	4	4	4	4	4	4
Bearing	68	2	4	4	4	4	4	4
Bolt: Bracing, M–3 (with nut)	1.0	4	12	16	20	28	20	28
Bolt: Chord (with nut)	7.5	----------	----------	----------	8	12	8	12
Bolt: Riband, Guard rail, "T", M–3	.75	8	8	8	8	8	8	8
Brace: Sway, M–3 (complete with pins)	72.5	2	2	2	2	2	2	2
Brace: Sway, O.H Ext., M–3 (with pin)	20	----------	----------	----------	----------	----------	----------	----------
Chess: M–3	130	13	13	13	13	13	13	13
Clamp: Transom, M–3	7	4	8	12	8	12	8	12
Footwalk	104	2	2	2	2	2	2	2
Frame: Bracing, M–3	42	----------	2	2	4	4	4	4

	pounds	S.S.	D.S.	T.S.	D.D.	T.D.	D.T.	T.T.
Panel	577	2	4	6	8	12	8	12
Pedestal: Ramp, M-3	97							
Pin: Panel (Complete with Safety Pin)	6.0	8	16	20	28	36	28	36
Pin: Panel, Headless, M-3 (do)	5.8			4		6		6
Post: End: Female	130	2	4	6	4	6	4	6
Post: End: Female, M-3	119							
Post: End: Male	121							
Post:End: Male, M-3	110							
Post: Footwalk	10	4	4	4	4	4	4	4
Raker: M-3	25	2	2		2		2	
Ramp: Plain	338							
Ramp: Button	349							
Riband: Guardrail (steel)	162	2	2	2	2	2	2	2
Riband: Guardrail, Long (steel) M-3	175							
Stringer: Button	267	2	2	2	2	2	2	2
Stringer: Button, Long, M-3	293							
Stringer: Plain	260	5	5	5	5	5	5	5
Stringer: Plain, Long, M-3	282							
Support: Bracing, Overhead	150							
Plate: Tie	3.5			2		2		2
Transom: M-3	648	2	2	2	2	2	2	2
Number of units		70	98	118	132	168	132	168
Total weight in pounds		8073	9791	11241	12323	14997	12323	14997
Total weight-short tons		4.04	4.90	5.62	6.16	7.50	6.16	7.50

Unit	Unit weight pounds	Intermediate bay							End bay at head of bridge						
		S.S.	D.S.	T.S.	D.D.	T.D.	D.T.	T.T.	S.S.	D.S.	T.S.	D.D.	T.D.	D.T.	T.T.
Plate: Base	381								2	2	2	2	2	2	2
Bearer: Footwalk	22	4	4	4	4	4	4	4	6	6	6	6	6	6	6
Bearing	68								2	4	4	4	4	4	4
Bolt: Bracing, M-3 (with nut)	1.0	4	12	24	20	36	28	48	8	16	32	32	56	40	68
Bolt: Chord (with nut)	7.5				8	12	20	28				8	12	8	12
Bolt: Riband, Guardrail "T", M-3	.75	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Brace: Sway, M-3 (complete with pins)	72.5	2	2	2	2	2	4	4	2	2	2	2	2	2	2
Brace: Sway, O.H., Ext., M-3 (with pin)	20						2	2							
Chess: M-3	130	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Clamp: Transom, M-3	7	4	8	12	8	12	8	12	6	12	18	12	18	12	18

Table 11–6. Number of Parts per Bay for Class 30 Bridges—Continued

Unit	Unit weight pounds	Intermediate bay							End of bay at tail of bridge						
		S.S.	D.S.	T.S.	D.D.	DD T.D.	D.T.	T.T.	S.S.	D.S.	T.D.	D.D.	T.D.	D.T.	T.T.
Footwalk	104	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Frame: Bracing, M–3	42		2	4	4	6	6	8		2	4	6	8	8	10
Panel	577	2	4	6	8	12	12	18	2	4	6	8	12	8	12
Pedestal: Ramp, M–3	97														
Pin: Panel (Complete with Safety Pin)	6.0	4	8	12	16	24	24	36	4	8	8	12	12	12	12
Pin: Panel, Headless, M–3 (do)	5.8										8		10		10
Post: End: Female	130														
Post: End: Female , M–3	119														
Post: End: Male	121								2	4	4	4	4	4	4
Post: End: Male, M–3	110										2		2		2
Post: Footwalk	10	4	4	4	4	4	4	4	6	6	6	6	6	6	6
Raker: M–3	25	2	2		2		2		4	4	2	4	2	4	2
Ramp: Plain	338														
Ramp: Button	349														
Riband: Guardrail (steel)	162	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Riband: Guardrail, Long (steel) M–3	175														
Stringer: Button	267	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Stringer, Button, Long M–3	293														
Stringer: Plain	260	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Stringer: Plain, Long, M–3	282														
Support: Bracing, Overhead	150						2	2							
Plate: Tie	3.5										2		2		2
Transom: M–3	648	2	2	2	2	2	3	3	4	4	4	4	4	4	4
Number of units		60	80	102	110	146	151	201	80	106	142	142	194	152	208
Total weight in pounds		6891	8189	9441	10697	13161	14368	18044	9459	11149	12668	13725	16448	13817	16544
Total weight—short tons		3.45	4.09	4.72	5.35	6.58	7.18	9.02	4.73	5.57	6.33	6.86	8.22	6.91	8.27

Table 11–7. Number of Parts per Bay for Class 80 Bridges

Unit	Unit weight pounds	End bay at tail of bridge						
		S.S.	D.S.	T.S.	D.D.	T.D.	D.T.	T.T.
Plate: Base	381		2	2	2	2	2	2
Bearer: Footwalk	22		4	4	4	4	4	4
Bearing	68		4	4	4	4	4	4
Bolt: Bracing, M–3 (with nut)	1.0		12	20	20	32	20	32
Bolt: Chord (with nut)	7.5				8	12	8	12
Bolt: Riband, Guard rail, "T", M–3	.75		8	8	8	8	8	8

Table 11–7. Number of Parts per Bay for Class 80 Bridges—Continued

Unit	Unit weight pounds	End bay ot tail of bridge						
		S.S.	D.S.	T.S.	D.D.	T.D.	D.T.	T.T.
Brace: Sway, M–3 (complete with pins)	72.5		2	2	2	2	2	2
Brace: Sway, O.H. Exr., M–3 (with pin)	20							
Chess: M–3	130		14	14	14	14	14	14
Clamp: Transom, M–3	7		12	18	12	18	12	18
Footwalk	104		2	2	2	2	2	2
Frame: Bracing, M–3	42		2	2	4	4	4	4
Panel	577		4	6	8	12	8	12
Pedestal: Ramp, M–3	97							
Pin: Panel (Complete with Safety Pin)	6.0		16	20	28	36	28	36
Pin: Panel, Headless, M–3 (do)	5.8			4		6		6
Post: End: Female	130		4	4	4	4	4	4
Post: End: Female, M–3	119			2		2		2
Post: End: Male	121							
Post: End: Male, M–3	110							
Post: Footwalk	10		4	4	4	4	4	4
Raker: M–3	25		2	2	2	2	2	2
Ramp: Plain	338							
Ramp: Button	349							
Riband: Guardrail (steel)	162							
Riband: Guardrail, Long (steel) M–3	175		2	2	2	2	2	2
Stringer: Button	267							
Stringer: Button, Long, M–3	293		2	2	2	2	2	2
Stringer: Plain	260	3	3	3	3	3	3	3
Stringer: Plain, Long, M–3	282		2	2	2	2	2	2
Support: Bracing, Overhead	150							
Plate: Tie	3.5			2		2		2
Transom: M–3	648		5	5	5	5	5	5
Number of units			106	134	140	184	140	184
Total weight in pounds			12015	13511	14547	17267	14547	17267
Total weight—short tons			6.01	6.76	7.27	8.63	7.27	8.63

Unit	Unit weight pounds	Intermediate bay							End of bay at tail of bridge						
		S.S.	D.S.	T.S.	D.D.	T.D.	D.T.	T.T.	S.S.	D.S.	T.S.	D.D.	T.D.	D.T.	T.T.
Plate: Base	381									2	2	2	2	2	2
Bearer: Footwalk	22		4	4	4	4	4	4		6	6	6	6	6	6
Bearing	68									4	4	4	4	4	4
Bolt: Bracing, M–3 (with nut)	1.0		12	24	20	36	28	48		16	32	32	56	40	68
Bolt: Chord (with nut)	7.5				8	12	20	28				8	12	8	12

Table 11–7. Number of Parts per Bay for Class 80 Bridges—Continued

Unit	Unit weight pounds	Intermediate bay							End of bay at tail of bridge						
		S.S.	D.S.	T.S.	D.D.	T.D.	D.T.	T.T.	S.S.	D.S.	T.S.	D.D.	T.D.	D.T.	T.T.
Bolt: Riband, Guardrail, "T", M-3	.75		8	8	8	8	8	8		8	8	8	8	8	8
Brace: Sway, M-3 (complete with pins)	72.5		2	2	2	2	4	4		2	2	2	2	2	2
Brace: Sway, O.H. Ext., M-3 (with pin)	20						2	2							
Chess: M-3	130		13	13	13	13	13	13		13	13	13	13	13	13
Clamp: Transom, M-3	7		12	18	12	18	12	18		12	18	12	18	12	18
Footwalk	104		2	2	2	2	2	2		2	2	2	2	2	2
Frame: Bracing, M-3	42		2	4	4	6	6	8		2	4	6	8	8	10
Panel	577		4	6	8	12	12	18		4	6	8	12	8	12
Pedestal: Ramp, M-3	97														
Pin: Panel (complete with Safety Pin)	6.0		8	12	16	24	24	36		8	8	12	12	12	12
Pin: Panel, Headless, M-3 (do)	5.8										8		10		10
Post: End: Female	130														
Post: End: Female M-3	119														
Post: End: Male	121									4	4	4	4	4	4
Post: End: Male, M-3	110										2		2		2
Post: Footwalk	10		4	4	4	4	4	4		6	6	6	6	6	6
Raker: M-3	25		2		2		2			4	2	4	2	4	2
Ramp: Plain	338														
Ramp: Button	349														
Riband: Guardrail (steel)	162		2	2	2	2	2	2		2	2	2	2	2	2
Riband: Guardrail, Long (steel) M-3	175														
Stringer: Button	267		2	2	2	2	2	2		2	2	2	2	2	2
Stringer, Button, Long, M-3	293														
Stringer: Plain	260		5	5	5	5	5	5		2	2	2	2	2	2
Stringer: Plain, Long, M-3	282									3	3	3	3	3	3
Support: Bracing, Overhead	150						2	2							
Plate: Tie	3.5										2		2		2
Transom: M-3	648		4	4	4	4	5	5		5	5	5	5	5	5
Number of units			86	110	116	154	157	209		107	143	143	195	153	209
Total weight in pounds			9513	10779	12021	14499	15692	19382		11863	13362	14489	17162	14531	17258
Total weight—short tons			4.76	5.39	6.01	7.25	7.85	9.69		5.93	6.69	7.22	8.58	7.27	8.63

CHAPTER 12

DECK TYPE BRIDGES

12–1. Deck Bridge Use

Deck type panel bridges are normally two-lane, class 50 or higher bridges assembled to replace single-lane bridges.

a. Advantages. Deck type panel bridges have the following advantages over through type bridges:

(1) Roadway can be wider for passage of extra-wide vehicles.

(2) Deck-type assembly allows greater side overhang of vehicles.

(3) A lighter floor system can be used when the roadway is supported by trusses.

(4) With some sloping banks, the span between abutments is shorter than in a through type bridge because bearings are set 5 feet below road level.

(5) Demolished piers need not be built up to the level of the roadway.

b. Disadvantages. Deck type panel bridges have the following disadvantages:

(1) Excavation at abutments may be necessary because bearings are 5 feet below the roadway.

(2) Bridge is more difficult to launch.

(3) Bridge must be lowered 5 feet onto the bearings.

(4) Waterway clearance is decreased.

12–2. Recommended Bridge Designs

a. Trusses. The trusses are grouped into three-truss girders, which are spaced evenly under the roadway. The trusses may be single- or double-story assembly as shown in figure 12–1.

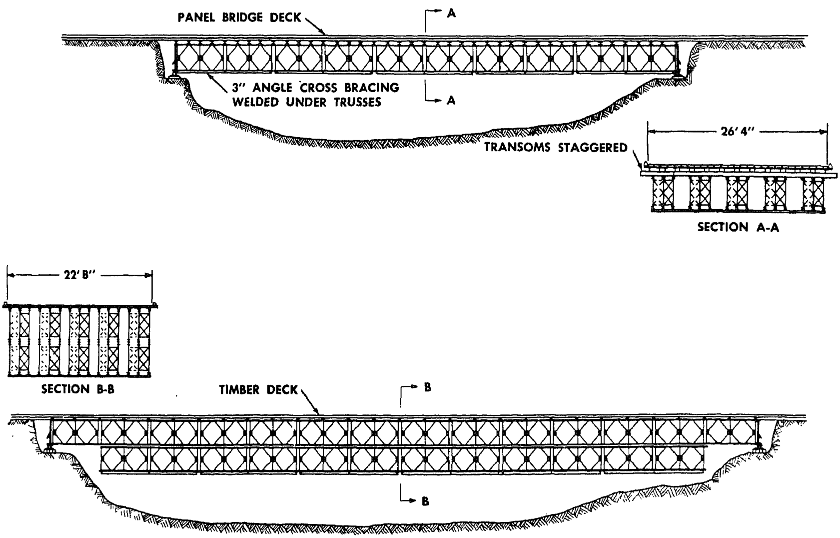


Figure 12–1. Standard two-lane, deck type, panel bridges.

b. Bracing. Bracing frames are used to tie the trusses of each girder together. Every two bays are cross braced by angles welded diagonally across the bottom chords of all trusses. The floor system serves as top lateral bracing.

c. Floor System. The floor system is made from standard panel bridge parts (transom, stringers, and chess) or timber.

d. Bearings.

(1) *End bearings.* End posts attached to top story panels may be rested on standard panel bridge bearings. In multistory assembly, the end panels of the lower stories are omitted to allow room for the abutment. If end posts are not used, the trusses rest on timber blocking or a rocker bearing under the joint between the first and second bay from each end.

(2) *Bearings at intermediate piers.* If the spans are broken at the pier, the two ends are fitted with end posts. If the spans are continuous, a distributing beam and rocker bearing are used (chap 16).

12–3. Class

The capacity of the standard two-lane deck type panel bridge varies with the span and the number of traffic lanes loaded. The bridges are given two class ratings, one for one-way traffic and the other for two-way traffic. Each of these ratings may be either a "single" or "dual" classification. For maximum spans and classes of standard design two-lane deck type bridges, see table 12–1.

12–4. Standard Designs

Standard design deck type panel bridges are illustrated in figure 12–1.

Table 12-1. Classes and Maximum Spans of Two-Lane, Deck Type Bailey Bridges

No. stories	Single						Double					
Type traffic	One way			Two way			One way			Two way		
Bridge length	No trusses 10	15	18	No trusses 10	15	18	No trusses 10	15	18	No trusses 10	15	18
50 ft				80/70								
60 ft				70/65								
70 ft				60/60	100/90							
80 ft	100/90			55/55	100/90	100/90						
90 ft	100/90			45/45	65/65	100/90				50/55		
100 ft	75/75			35/35	50/50	80/70				50/50		
110 ft	55/60	100/90			40/40	65/65				45/50		
120 ft	45/45	85/90	100/90			50/55				40/45	80/75	
130 ft	35/35	70/70	90/90			40/45	85/85			40/40	70/70	90/90
140 ft		55/55	75/75				75/75				60/60	80/80
150 ft		40/45	60/60				60/60				50/55	65/70
160 ft			45/50				45/50	90/90			40/45	55/60
170 ft			35/35				35/35	70/75	95/90			45/50
180 ft								55/60	75/80			
190 ft								40/45	60/65			
200 ft								30/30	45/45			
210 ft									30/30			

12-5. Assembly

a. Trusses. The most practical load distribution is obtained by spacing the trusses uniformly under a relatively stiff deck. Five three-truss girders (15 trusses) are used under the bridge deck. Trusses in each girder are spaced 1 foot 6 inches apart and tied together with bracing frames.

b. Bracing.

(1) *Bracing frames.* Bracing frames are used as much as possible at panel junctions to space the trusses and to provide lateral stability in each three-truss girder.

(2) *Angles.* Three-by-three-inch angles are welded diagonally across the bottom chords of each two bays to brace and tie the five three-truss girders together. Welding must be done carefully so the properties of the high tensile steel in the panel bridge parts are not changed. Mild steel bracing members should be used, and they should be welded in place before any loads are applied to the bridge.

c. Flooring. Before the timber decking is laid, 3-inch angles are welded transversely to the top chords of the trusses at 5-foot centers. These angles tie the trusses together and provide a brace for clamping the riband bolts. The timber flooring can be laminated or laid in two layers.

(1) *Laminated flooring (fig 12-2).* Laminated flooring is better than layered flooring because the nails cannot work out under traffic vibration, thereby reducing maintenance. The timbers are laid on edge perpendicular to the long axis of the bridge and nailed together horizontally. For ease of assembly 2-1/2-foot sections of laminated floor can be prefabricated before hand and then two sections are laid between each pair of angles. The end timber of each section is notched to fit over the horizontal legs of the angles. Timber wear treads are then nailed to the floor.

(2) *Layered flooring (fig 12-3).* Three-by-twelve-inch planks are laid across the trusses between the angles. Every fifth timber is notched to fit over the horizontal legs of the angles. Timber wear treads are then nailed to the floor.

d. Bearings.

(1) *With end posts (fig 12-4).* End posts are used at both ends of each truss and seated on standard bearings. The top lugs of the end posts are cut off flush with the trusses so they do not interfere with the decking.

(2) *Without end posts (fig 12-5).* If end posts are not used, the span is supported on timber blocking at the first panel junction from each

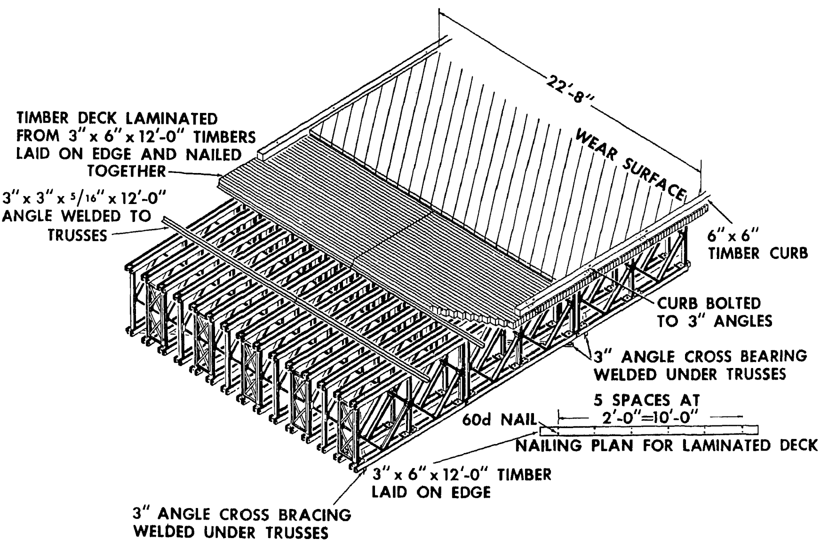


Figure 12-2. Details of laminated timber deck on a two-lane deck type panel bridge.

end. The timber blocking must extend a minimum of 1 foot on each side of the joint. An alternate method is to use a distributing beam on a rocker bearing similar to the support over immediate piers. With this type of bearing, the effective bridge length is 20 feet greater than the gap between bearings. Timber blocking is also added under the cantilevered end of the panel to elimi-

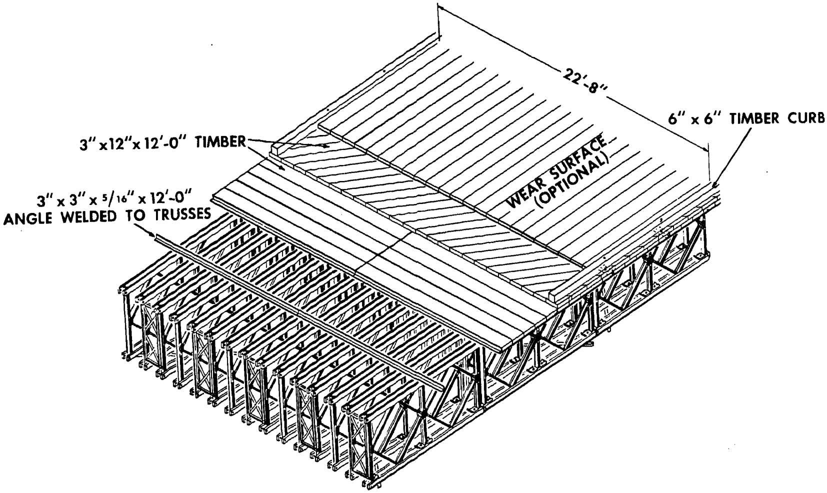
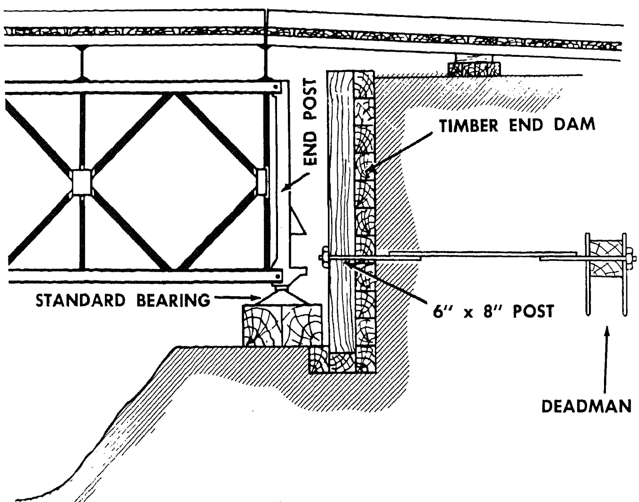


Figure 12–3. Details of layered timber deck on a two-lane deck type panel bridge.



(3) *Over intermediate piers.* The trusses can be continuous or broken over the intermediate piers. If they are continuous, a rocker bearing should be provided (chap 16). If broken, end posts are attached to the ends of the trusses and two ends are seated on separate bearings. If timber flooring used, the gap between the ends of the spans may require an intermediate trestle to support the decking (fig 12–6). With panel bridge flooring, the gap between the ends of spans can be

12–6. Expedient Assembly

For ease in launching, trusses may be grouped into two- or three-truss girders tied together by bracing frames. (These girders are spaced uniformly under the deck.) If other spacings of the trusses are used, expedient braces must be welded to the end verticals of the panels in place of bracing frames. Cross bracing must also be welded across the bottom chords. Examples of expedient assembly are given in table 12–2.

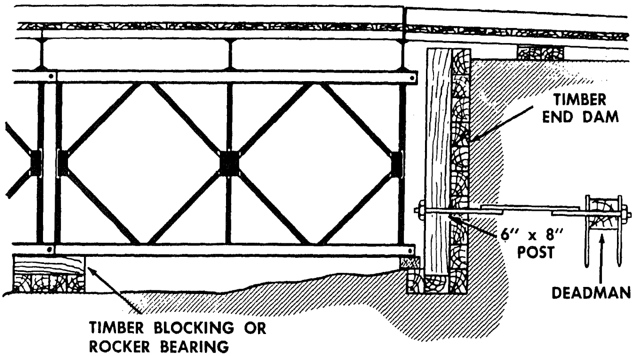


Figure 12–5. End bearings for deck type panel bridges, without end posts. Last bay is cantilevered over the timber or rocker bearings.

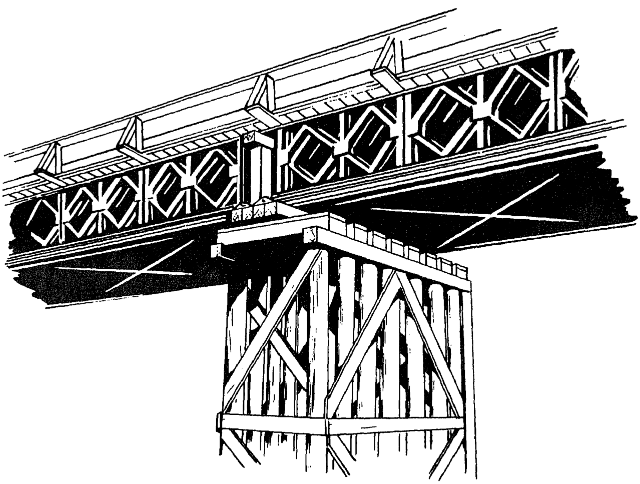


Figure 12–6. Junction of two deck spans on an intermediate pier. Timber bent supports the decking between ends of span.

12–7. Launching

a. Method.

(1) Each three-truss girder may be launched separately or the entire bridge may be launched as a unit by welding additional bracing to tie the girders togehter.

(2) The individual girders of a single-story bridge are launched by pushing or pulling the girder and launching nose out over the gap, by launching from a high line, by launching with derrick and preventer tackle, or by lifting directly into place with one or two cranes. Over a water gap the girders may be placed on rafts and floated out into the gap and then lifted into place by a crane on a raft. For details of these launching methods see chapter 19.

(3) A single-story bridge may also be launched as a unit by pushing or pulling it on rollers out over the gap.

(4) Double-story bridges are launched as a unit. Transverse channels welded across the tops of the bottom and intermediate chords tie the girders together. The entire unit may be launched with a launching nose and then jacked down onto the bearings. If a temporary pier can be built in the middle of the gap to support the cantilevered end, the bridge can be launched as a single-story unit, the lower story being added from an erection platform just below the near bank seat. This method reduces the jacking height. It is similar to the method for launching triple-story bridges with the underslung bottom story described in chapter 9.

b. Lowering to Bearings. A crane at each end of the bridge can be used to lower the girders to the bearings. Jacks can be used as an expedient, although the 5-foot drop requires several lifts. During jacking, blocking must be used under the trusses to take the load in case the jacks fail.

12–8. Expedient Design Bridges

Table 12–2 lists several typical World War II deck type panel bridges built in the European Theater of Operations (ETO).

Table 12–2. Typical Highway Deck Type Panel Bridges Built in ETO

Location	Tiber River, Borghetto, Italy.	Autobahn Highway, Bayreuth, Germany.	Arno River, Pisa, Italy	Po River, Ostiglia, Italy.
Span	Continuous over four spans at 80, 90, 90, and 80 feet.	Continuous over two 55-foot spans.	Continuous over two 85–foot spans.	Continuous over thirteen 100-foot spans.
Capacity*				
One way	Class 80	Class 80	Unknown	Class 100.
Two way	Class 45	Class 45		Class 55.
Road width (feet)	24	25	20	About 22.
Truss construction	18 trusses tied together by vertical bracing frames and tie plates into 2 five-truss and 2 four-truss girders.	8 trusses tied together by vertical bracing frames into 4 two-truss girders.	10 trusses tied together by vertical bracing frames into 5 two-truss girders.	16 trusses tied together by vertical bracing frames into 8 two-truss girders.
Special bracing	3″ x 3″ angle cross bracing welded under bottom chords.	6″ channels transverse to center line of bridge welded to top and bottom chords at 20′ spacings.	10″ steel I-beam floor beams welded across top chords at 2′–6″ spacings.	Angle cross bracing welded under bottom chords.
Deck	3 layers of 2″ timber nailed to nailing strips bolted to trusses. Bottom 2 layers laid diagonally, top layer laid transversely, and surfaced with bituminous surfacing.	9″ timber flooring nailed to nailing strips bolted to trusses.	2 layers of 3″ timber nailed to nailing strips bolted to floor beams.	2 layers of timber nailed to nailing strips bolted to trusses. Bottom layer laid transversely, top layer laid diagonally.
Launching	Each girder launched separately. Girder and launching nose pulled on rollers cut over gap.	Each girder launched separately on rollers.	Entire unit launched on rollers without a launching nose.	Each girder lifted directby into place by pile driving rig.

*Capacities are those assigned to bridge in the field. Actual capacity may be greater.

CHAPTER 13

RAILWAY BRIDGES

13–1. Bridge Use

Panel bridge equipment can be used as an expedinet for the assembly of railway bridges. However, it should be used only under special conditions since there is a great amount of deflection. Spans longer than 70 feet are normally impractical because a quadruple-double truss bridge is required (table 13–1). Usually, panel bridge railway bridges are assembled as single-track bridges.

Table 13-1. Number of Trusses Required for Various Spans of Bailey Type Panel Railway Bridge

Span (ft.)	Standard Cooper's E–45 loading [1]			Modified Cooper's E–45 loading [1]		
	Through type bridge [2]	Deck type bridge [3]		Through type bridge [2]	Deck type bridge [3]	
		Type I	Type II		Type I	Type II
10	DS	---	---	DS		
20	DS	---	---	DS		
30	TS	6	---	TS	6	
40	QS and DD	7	7	QS and DD	7	7
50	QS and DD	8	8	QS and DD	8	8
60	TD	9	9	TD	9	9
70	QD	10	10	QD	10	10
80	QD	11	12	QD	11	12
90	---	---	16	---	---	16
100	---	---	16	---	---	16

[1] Including an allowance of 25 percent of live load for impact.
[2] Based on the following allowable loads:

Construction	SS	DS	TS	QS	DD	TD	QD	DT	TT
Allowable shear (tons)	40	80	110	140	135	175	215	135	175
Allowable moment (ft.-ton)	760	1520	2080	2640	2800	3760	4720	5240	7024

[3] Based on allowable shear in each truss of 20 tons, allowable moment in each truss of 380 foot-tons, and 90 percent truss efficiency.

a. Advantages. Panel bridge equipment has the following advantages for use as railway bridging:

(1) The equipment can be transported in trucks to the bridge site. This permits bridge assembly at the same time repairs are being made on the approach tracks.

(2) Either through- or deck-type bridges can be assembled.

b. Disadvantages. Panel bridge equipment has the following disadvantages for use as railway bridging:

(1) Through-type bridge provides restricted clearance.

(2) Traffic over bridge must be controlled to eliminate excessive vibration and side sway.

(3) Pin clearance allows more sag than is found in a normal bridge.

(4) Bridge requires more maintenance than standard bridges.

13–2. General Description

a. Through-Type Bridge. The through-type railway bridge is assembled the same as the normal panel bridge, except ties and rails are used in place of chess. Girders can be single-, double-, triple-, or quadruple-truss and single- or double-story. The trusses of double-story bridges infringe US main line and Berne international clearance gages but allow passage at slow speeds (fig 13–1 and 13–2). If flooring of double-story trusses is placed in the top story, the trusses do not infringe standard clearance gages.

b. Deck-Type Bridge. In the deck-type bridge, the trusses are spaced under the ties. The trusses are usually single-story. They are tied together

laterally by bracing frames, tie plates, expedient angle cross bracing, and the ties.

13–3. Class

The standard designs described will carry standard or modified Cooper's E–45 loading. See figure 13–3 for diagrams of loadings. Table 13–2 gives the shears and moments caused by these loadings. Table 13–1 gives the assembly required for 10- to 100-foot spans using two standard designs.

Table 13–2. Maximum Live-Load Moments and Live-Load Shear Caused by Cooper's E–45 Loadings

Span (ft)	Standard Cooper's E–45 loading (Two Locomotives)		Modified Cooper's E–45 loading (Single Locomotive)	
	Maximum Shear (tons)	Maximum Moment (ft.-tons)	Maximum Shear (tons)	Maximum Moment (ft.-tons)
10	34	63	34	63
20	56	232	56	232
30	71	462	71	462
40	85	739	85	739
50	98	1,060	98	1,060
60	110	1,460	110	1,446
70	124	1,920	122	1,845
80	139	2,440	134	2,303
90	154	3,000	145	2,791
100	169	3,630	158	3,312

13–4. Assembly of Through-Type Bridge

a. Trusses. Single-, double-, and triple-truss assembly can be used as in normal panel bridge assembly. A quadruple truss can be assembled by inserting a fourth truss between the inner and second truss of triple-truss assembly. Bracing frames and tie plates are used to tie the four trusses together (fig 13–4). Transom clamps are used on all panel verticals except the three verticals in each bay covered by bracing frames. Transoms are modified by cutting a hole in the flange and web at each end to seat the pintle of the fourth truss. Since the fourth truss interferes with the use of rakers, double-story quadruple-truss bridges are usually assembled with the floor in the top story.

b. Floor System. For railway loads, double transoms are always used. Stringers are placed as in a normal panel bridge. If 8- by 10-inch by 14-foot ties are used, they are placed directly on the stringers at 2-inch spacings and hook-bolted to the button stringers (fig 13–5). To use standard ties (6 by 8 inches by 8 feet 6 inches), chess and ribands are laid in the normal manner and the ties are spiked to the chess (fig 13–6). By building up timber treads on each side and between the rails, the bridge can be used for rail or highway

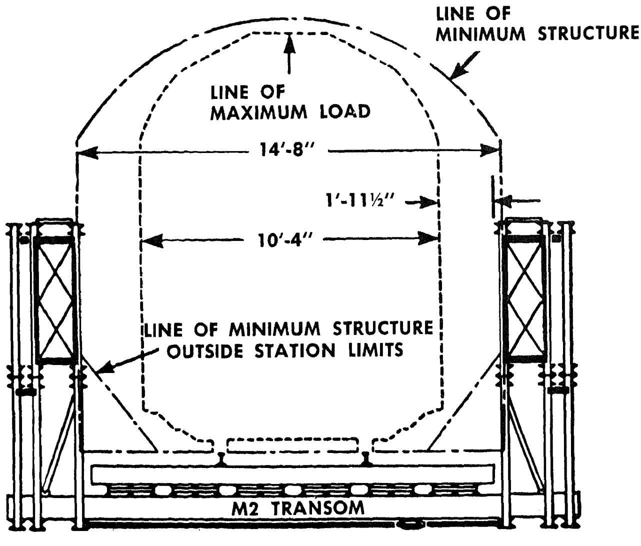


Figure 13–1. Railway clearance diagrams for M2 through-type panel bridges, Berne international.

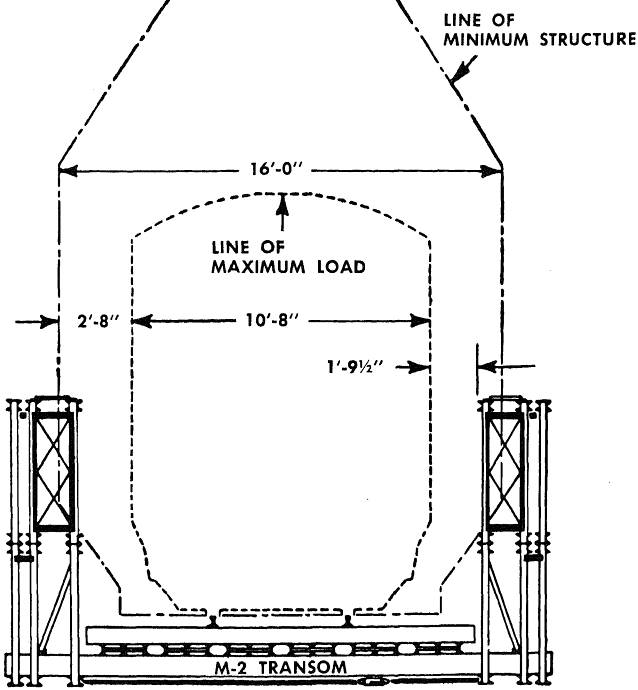


Figure 13–2. Railway clearance diagrams for M2 through-type panel bridges, US unrestricted main line.

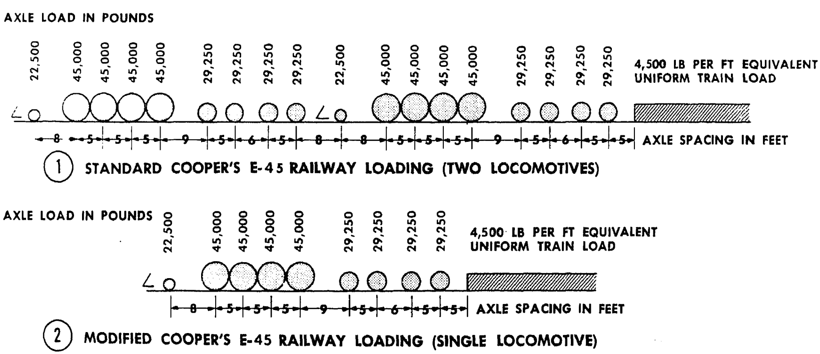


Figure 13–3. Diagram of standard and modified Cooper's E–45 loadings.

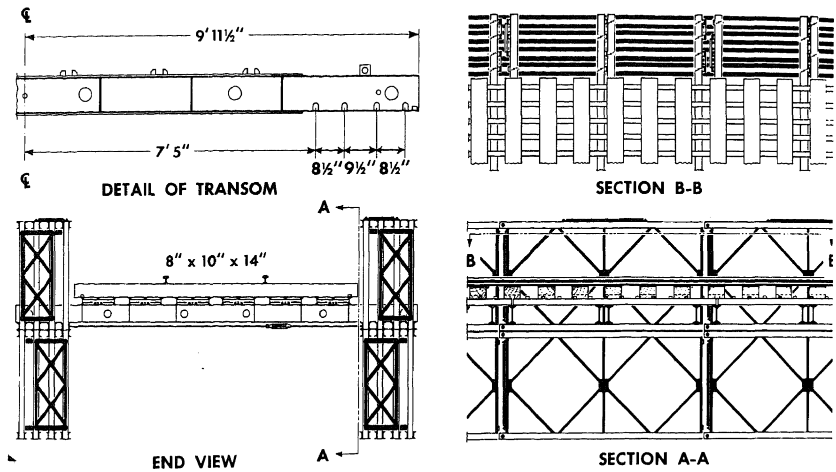


Figure 13–4. Quadruple-truss double-story through-type panel railway bridge.

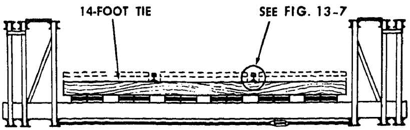


Figure 13–5. Decking of through-type panel railway bridge, using 14–foot ties.

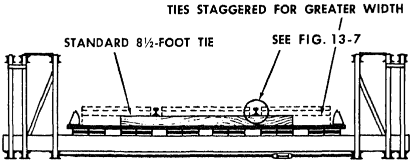


Figure 13–6. Decking of through-type panel railway bridge, using standard 8½–foot ties.

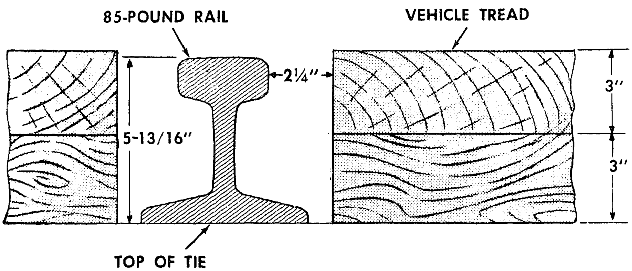


Figure 13–7. Decking of through-type panel railway bridge, detail of vehicle tread for combination highway-railway bridge.

traffic (fig 13–7). Rail joints on the bridge should be tight (no allowance for expansion) to reduce impact.

c. End Bearings. End posts and bearings are used as in a normal panel bridge. Grillage must be enough to carry the loads given in table 13–3. Ramp sections must be level with the bridge floor.

a. Type I.

(1) *Trusses.* Trusses are arranged side by side and connected by bracing frames and tie plates as shown in figures 13–8 through 13–15. Bracing is supplied by the ties, welded sway bracing, and modified transoms. The modified transoms are seated adjacent to the center vertical in the top and bottom chord of every second and third bay. To seat the upper transom, every other truss is inverted. The modified transoms are cut to the desired length and holed to seat the pintles on the panels. Three-inch angle sway bracing is welded diagonally under the bottom chords of every two bays.

Span (ft.)	Standard Cooper's E–45 loading			Modified Cooper's E–45 loading		
	Through type bridge*	Deck type bridge		Through type bridge*	Deck type bridge	
		Type I	Type II		Type I	Type II
10	45	------	------	45		
20	75	------	------	75		
30	97	93	------	97	93	
40	116	111	113	116	111	113
50	138	131	132	138	131	132
60	159	149	150	159	149	150
70	180	169	170	177	167	168
80	206	191	192	196	185	185
90	227	214	215	216	203	204
100	------	------	243	236	------	228

*Sum of reactions on both base plates.

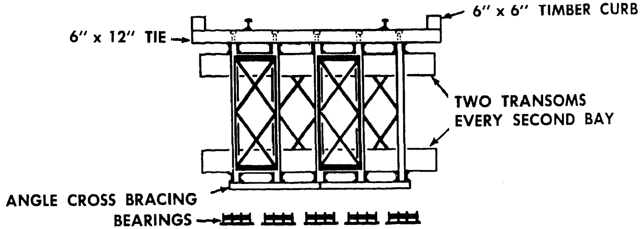


Figure 13–8. Five-truss railway bridge.

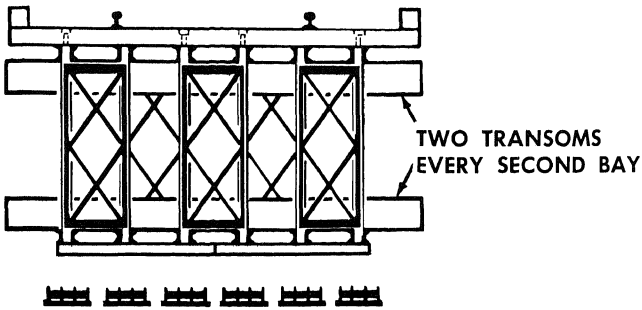


Figure 13–9. Six-truss railway bridge.

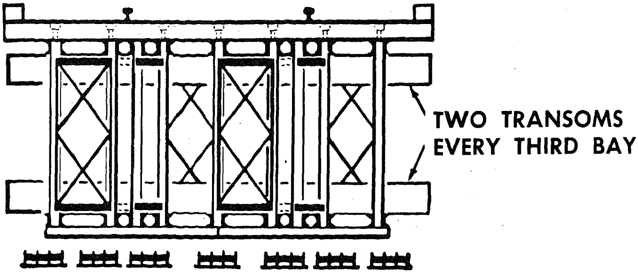


Figure 13–10. Seven-truss railway bridge.

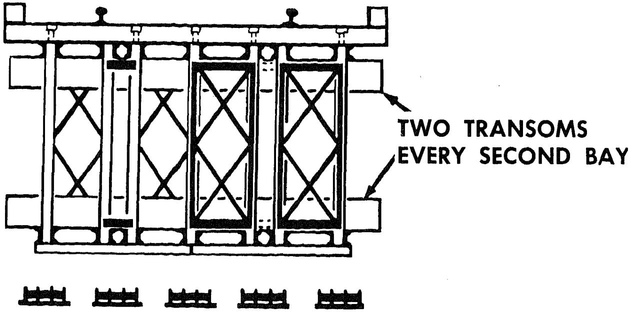


Figure 13–11. Eight-truss railway bridge.

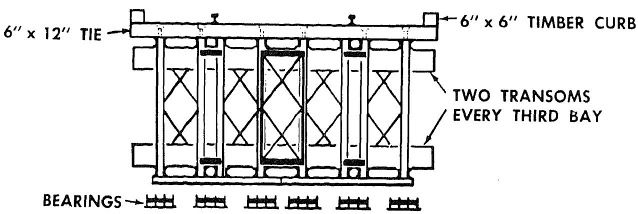


Figure 13–12. Nine-truss railway bridge.

(2) *Floor system.* Four 6- by 12-inch ties are used in each bay. Every other tie is chord bolted to the trusses. Holes for the chord bolts are drilled as shown in figure 13–16. A 6- by 6-inch curb is spiked to the ties.

(3) *End bearings.* End posts are used at each end of each truss and are seated on standard bearings. Grillage under the bearings at each abutment must be sufficient to support loads given in table 13–3. Rocker bearings over intermediate piers can be made similar to those described in chapter 16.

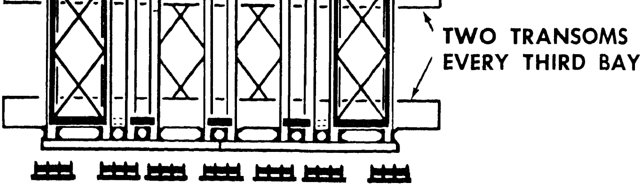


Figure 13–13. Ten-truss railway bridge.

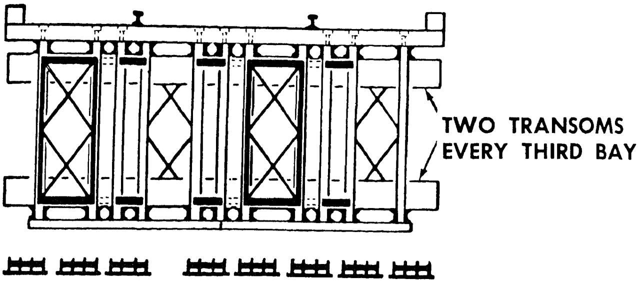


Figure 13–14. Eleven-truss railway bridge.

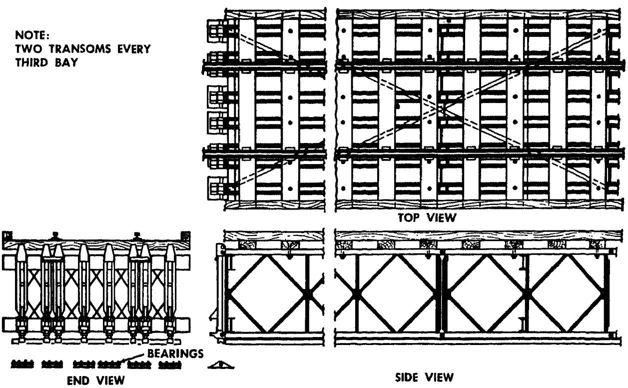


Figure 13–15. Top, side, and end view of eight-truss bridge showing construction details.

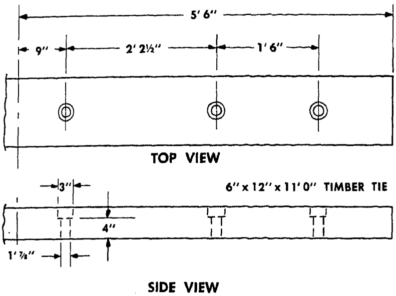


Figure 13–16. Details of railway tie for eight-truss bridge showing chord bolt holes.

b. Type II.

(1) *Trusses.* Trusses are braced by bracing frames and tie plates into two-, three-, or four-truss girders suitable for launching separately. The girders are grouped together to form six-, seven-, eight-, nine-, 10-, 12-, and 16-truss bridges as illustrated in figures 13–17 to 13–24. The two-truss girder is made from two trusses braced at the end verticals by bracing frames. A 3-foot wide three-truss girder is made from three trusses braced by bracing frames. A 1½-foot three-truss girder is made by adding a third truss between the trusses of the two-truss girder and bracing it with tie plates to one of the outer trusses. A four-truss girder is made by adding another truss 8½ inches outside a 1½-foot three-truss girder and bracing it with tie plates. The girders are tied together in the bridge by the ties and two modified transoms on the bottom chord of each bay. Transoms are modified by cutting holes in the flange to seat the pintles on the panels. Raker lugs

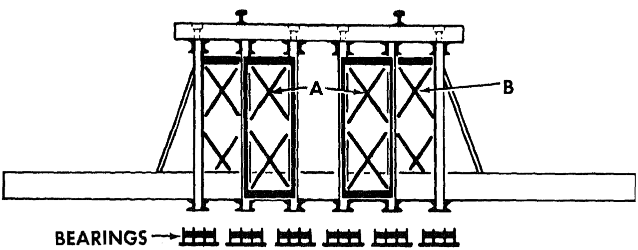


Figure 13–17. Six-truss railway bridge.

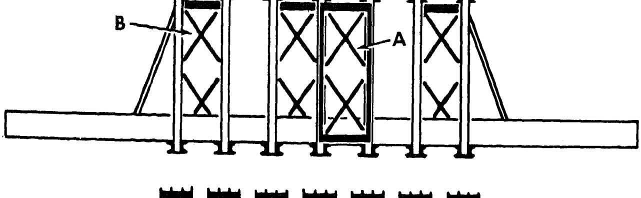


Figure 13–18. Seven-truss railway bridge.

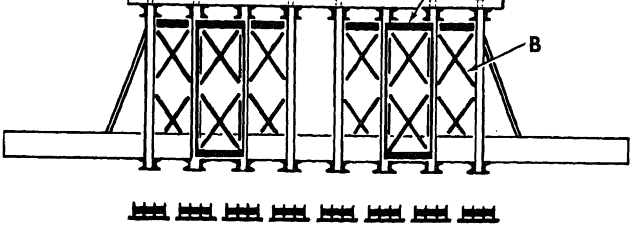


Figure 13–19. Eight-truss railway bridge.

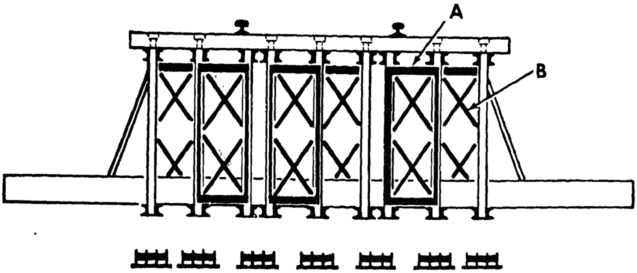


Figure 13–20. Nine-truss railway bridge.

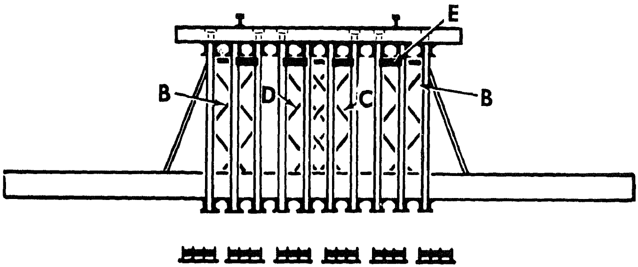


Figure 13–21. Ten-truss railway bridge.

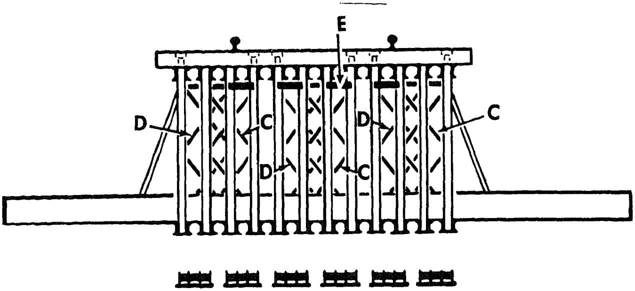
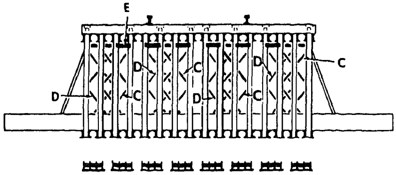


Figure 13–22. Twelve-truss railway bridge.



LEGEND FOR FIGS. 13.17-13.23

BRACING FRAMES

A – ON FRONT END OF PANELS IN EVERY BAY
B – ON BACK END OF PANELS IN EVERY BAY
C – ON BACK END OF PANELS IN ODD NUMBERED BAYS
D – ON BACK END OF PANELS IN EVEN NUMBERED BAYS

TIE PLATES

E – ON FRONT END OF PANELS IN EVERY BAY

Figure 13–23. Sixteen-truss railway bridge.

are welded to the transom so rakers can be used between the transom and the outside trusses.

(2) *Floor system.* The same floor system is used as in the type I bridge.

(3) *End bearings.* Bearings of the same type as in the type I bridge are used.

13–6. Launching

a. Through-Type Bridge. Through-type bridges are launched on rollers in the same manner as a normal panel bridge.

b. Deck-Type Bridge.

(1) *Type I bridge.* These bridges are designed to be launched complete on rollers. They can be pushed across or pulled across by a winch line. Launching noses can be used as illustrated in figures 13–25 through 13–32. During launching,

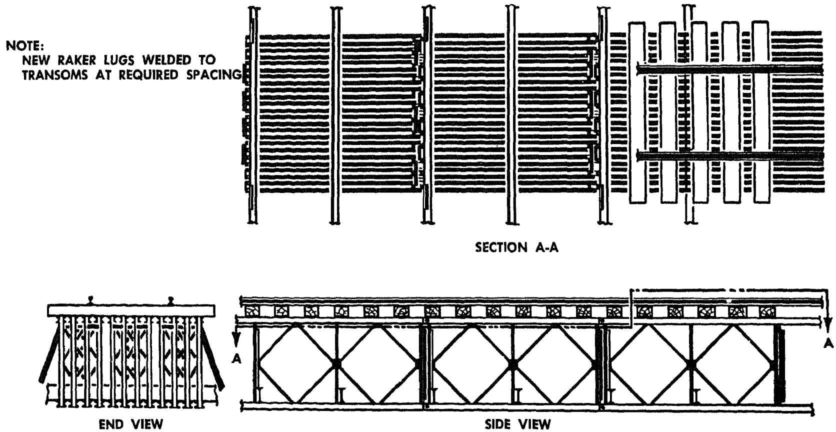


Figure 13–24. Top, side, and end view of twelve-truss bridge showing construction details.

extra bracing frames and tie plates are used on the top chords.

(2) *Type II bridge.* Each girder of the bridge is launched separately by cantilevering out on rollers. Flooring and bracing between girders are added after girders are in place. For other methods of launching single girders, see chapter 19.

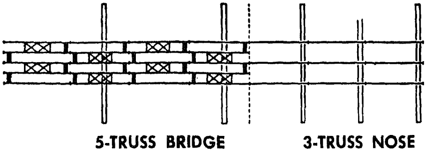


Figure 13–25. Three-truss nose for five-truss bridge.

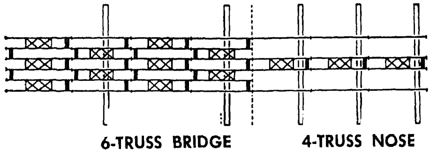


Figure 13–26. Four-truss nose for six-truss bridge.

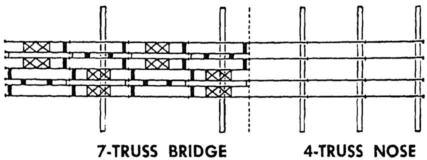


Figure 13–27. Four-truss nose for seven-truss bridge.

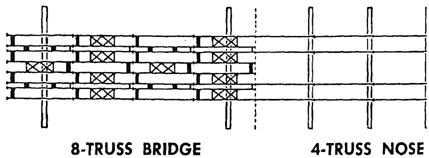


Figure 13–28. Four-truss nose for eight-truss bridge.

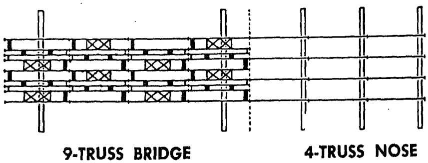


Figure 13–29. Four-truss nose for nine-truss bridge.

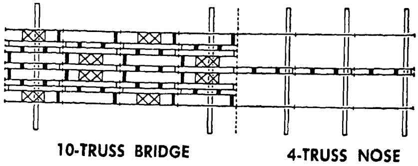


Figure 13–30. Four-truss nose for ten-truss bridge.

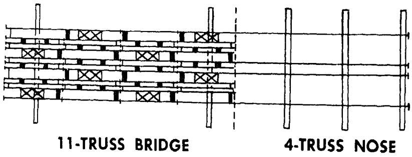


Figure 13–31. Four-truss nose for eleven-truss bridge.

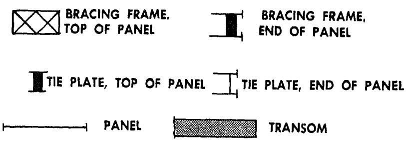


Figure 13–32. Symbols used in figures 13–25 through 13–31.

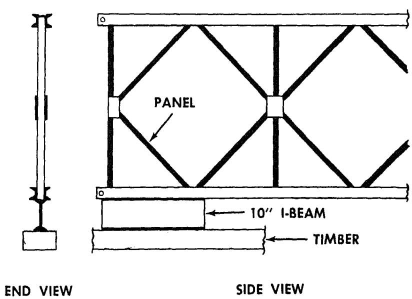


Figure 13–33. Expedient and bearings for deck panel bridge. Rigid distributing beam must support at least two panel-support points.

13–7. Expedients

Table 13–4 lists panel railway bridges built in World War II in the European theater of operations. Figures 13–33 through 13–39 illustrate expedient bridges.

a. Bracing. Welded vertical cross bracing at each panel junction can be used instead of bracing frames and tie plates. Four-inch channels welded across the panel chords can be used in place of transoms.

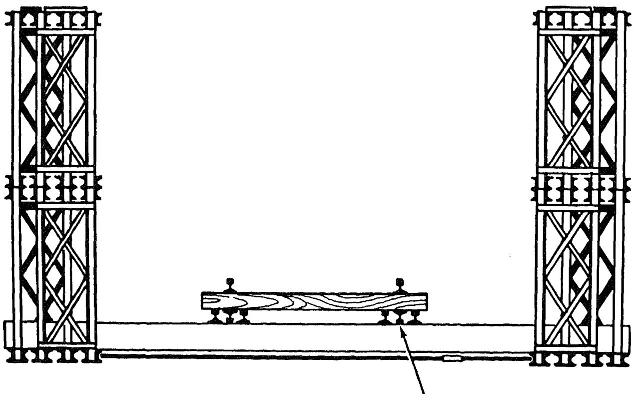


Figure 13–34. End view of 90-foot QD railway bridge built to carry the equivalent of Cooper's E–35 loading.

Table 13–4. Typical Railway Panel Bridges Built in ETO

Location	Kings Newton bridging school at Melbourne, Derby, England.	Railway bridging school at Rakha Mines, India.	Sicily	Ofanto River near Melfi, Italy.
Span	90 feet	80 feet	120 feet (continuous over two 60-foot spans).	Three 60-foot spans.
Capacity	2–8–0 armored locomotive (equivalent to Cooper's E–35).	16 B.S.S. (equivalent to Cooper's E–35).	Not known	Class 70 (modified Cooper's E–40).
Number of trusses	QD	QD	TD	TD—Deck in top story.
Bracing	Normal	Normal	Normal	Normal.
Decking	Ties on two lines of rail clusters (3 rails in each cluster). Double transoms.	6″x8″x7′ ties at 1′8″ centers. Every third tie hook bolted to standard stringers. Outer stringers omitted. Double transoms.	Every 7th tie spiked to standard chess on stringers. Double transoms. Timber treads built up on each side of rails for highway traffic.	Ties at 2′6″ centers. Double transoms. Ties bolted every 10′ to plate under two transoms.
Bearings	Standard end posts and bearings.	Standard end posts and bearings.		Standard end posts and bearings.
Construction time				5 days.
Method of launching				120 feet launched with 70-foot nose from one bank. 60 feet launched with tail from other bank.
Figure reference	13–34	13–35	13–36	13–37

Location	Cevaro River near Foggia, Italy.	Durance River near Meyrargues, France.	Durance River south of Sisteron, France.	Durance River at Sisteron, France.
Span	Three spans at 40 feet, 80 feet, and 40 feet.	170 feet continuous over two spans of 80 feet and 90 feet.	90 feet (continuous over two 40-foot spans and 10-foot wide pier).	60-foot span and 120 feet (continuous ovez two 60-foot spans).
Capacity	Class 70 (modified Cooper's E–40).	80-ton concentrated load string of 40-ton cars without locomotive.	Modified Cooper's E–40.	Modified Cooper's E–40.
Number of trusses	TD—deck in top story	8 trusses grouped into two 4-truss girders.	6 trusses grouped into two 3-truss girders.	6 trusses grouped into two 3-truss girders.
Bracing	Normal	Bracing frames and tie plates.	Tie plates in each girder. Angle iron vertical cross bracing welded to panel verticals. Horizontal braces welded to bottom chords adjacent to panel verticals.	Bracing frames and tie plates —3-inch channel sway bracing welded under trusses.
Decking	Ties at 2′6″ centers. Every fourth t'e bolted to plate under transoms. Double transoms.	Ties at 2′6″ centers, chord bolted to trusses.	Ties at 16″ centers bolted to longitudinal timbers fixed to top chords of trusses.	Ties at 2′6″ centers bolted to trusses.
Bearings	Standard end posts and bearings.	Rigid distributing beam under two node points seated on timber at abutments and piers.	Timber bearings	Underslung second story seated on timber at abutments. Steel rocker bearings on timber pier cap.
Construction time	5 days	23 days	9 days	20 days (including 60-foot panel crib pier).
Method of launching	120 feet launched with 70-foot nose from one bank. 40 feet launched from other bank.	Each 170-foot truss placed by high line. Bracing added after trusses were in place.	Entire bridge cantilevered into place.	60-foot and 120-foot trusses lifted directly into place by cranes.
Figure reference	13–37		13–38	
Location	Montrond bridge over Buech River at Serres, France.	Pont d'Ain bridge over Ain River near Poncin, France.	Suran River near Poncin, France.	Arbois, France.
Span	40 feet (continuous over two 20-foot spans).	170 feet (continuous over two 85-foot spans).	90 feet	70 feet (continuous over two 35-foot spans).
Capacity	Modified Cooper's E–40	Modified Cooper's E–40	Modified Cooper's E–40	Modified Cooper's E–40.
Number of trusses	4 trusses grouped into two 2-truss girders.	9 trusses	10 trusses	6 trusses grouped into two 3-truss girders.
Bracing	Tie plates in each girder. Angle iron vertical cross bracing welded to panel verticals.	Bracing frames, tie plates, and modified transoms.	Bracing frames and tie plates. Angle iron sway bracing welded under trusses.	Tie plates in each girder. Angle iron vertical cross bracing welded to panel verticals. Horizontal braces welded to bottom chords adjacent to panel vezticals.
Decking	Ties at 16″ centers bolted to longitudinal timbers fixed to top chords of trusses.	Ties at 2′6″ centers, chord bolted to trusses.	Ties at 2′6″ centers, chord bolted to trusses.	Ties at 16″ centers bolted to longitudinal timbers fixed to top chords of trusses.
Bearings	Timber bearings		Rigid distribution beam under two node points at each end. One end on steel plate for expansion.	Timber bearings.
Construction time	3 days		4 days	

Table 13–4. Typical Railway Panel Bridges Built in ETO—Continued

Method of launching	Trusses manhandled into position.	Entire unit launched with 4-truss launching nose. Launching links between 2nd and 3rd bays. Bridge pulled across by winch, 16 jacks used to jack down.	Entire bridge launched with 4-truss launching nose. Bracing frames on top chord during launching only.	Entire bridge lau on rollers.
Figure reference	13–39			
Location	Doubs River at Dole, France.	Langley bridge over Moselle River near Charmes, France.		
Span	460 feet (continuous over six 76½-foot spans).	450 feet (continuous over seven 64-foot spans).		
Capacity	Modified Cooper's E–40	Modified Cooper's E–40.		
Number of trusses	10 trusses grouped into two 5-truss girders.	8 trusses.		
Bracing	Tie plates in each girder. 4-inch channel vertical cross bracing welded to panel verticals. 4-inch channel horizontal braces welded to top and bottom chords in each bay.	Bracing frames, tie plates, and transoms. 3-inch angle sway bracing welded under trusses.		
Decking	Ties at 2′6″ centers, chord bolted to trusses.	Ties at 2′6″ centers, chord bolted to trusses.		
Bearings	Steel distributing plate under two node points set on timber pier caps. Angle cleats for side guides.	Modified end posts at abutments. 8′9″ distributing beam under 3 node points over piers. Distributing beam rocks on standard bearings on greased steel plates between angle guides.		
Construction time	20 days	19 days.		
Method of launching	½ bridge cantilevered out from each bank. No launching nose. Pulled across by winch.	260 feet pulled by winch from one bank. 190 feet pulled from other bank. No launching nose used.		

b. Bearings. If end posts are not used, the abutment bearings can be made from a rigid distributing beam on timber grillage. The beam must support at least two panel support points (fig 13–33).

c. Launching. Each truss or two-truss can be launched from a high-line or lifted into place by a crane.

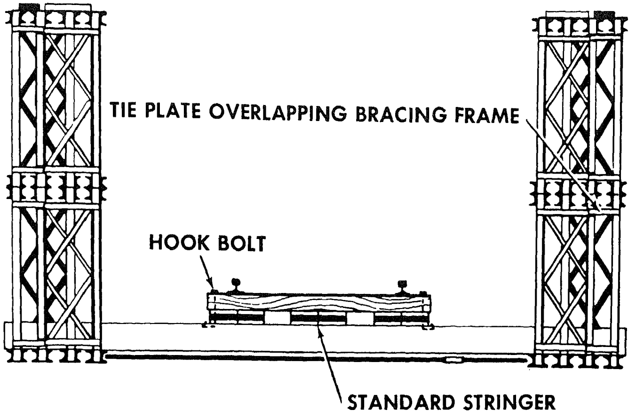


Figure 13–35. End view of 80-foot QD railway bridge built to carry the equivalent of Cooper's E–35 loading.

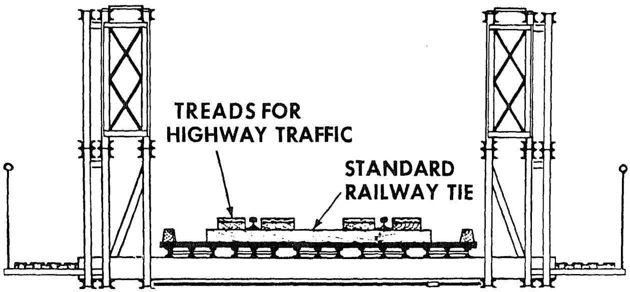


Figure 13–36. End view of TD combination highway-railway bridge.

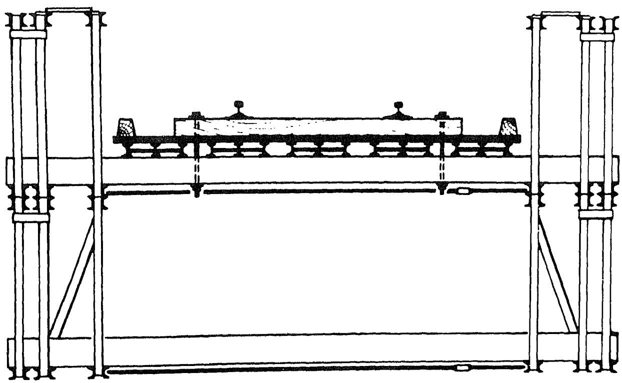


Figure 13–37. End view of TD class 70 railway bridge.

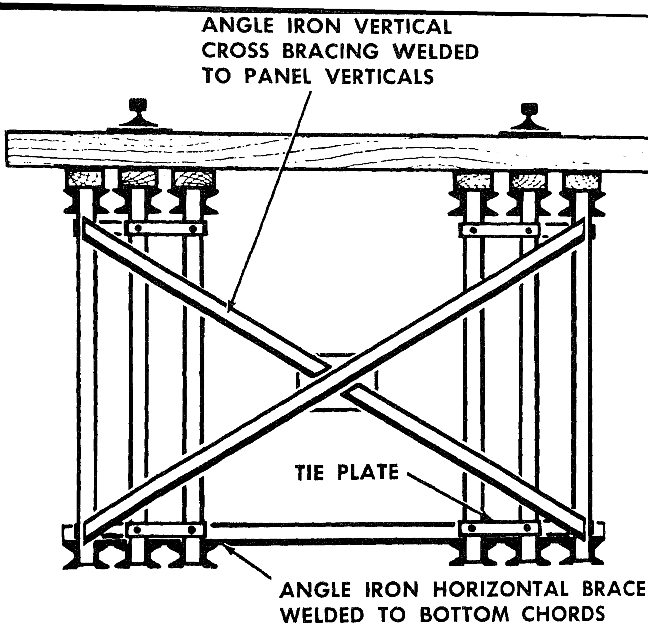


Figure 13–38. End view of six-truss deck railway bridge.

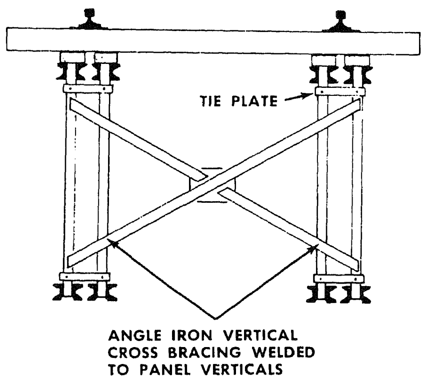


Figure 13–39. End view of four-truss deck railway bridge.

CHAPTER 14

REINFORCED BRIDGES

14–1. Design

The critical design factor in most fixed panel bridges is bending moment. This factor varies from a maximum at the center of the span to zero at the supports. Unit assembly of the panel bridge, however, produces girders of uniform section and strength throughout their entire length. Only center bays of most spans are therefore fully stressed. The greater part of the capacity of end bays is not used. By reinforcing only the center bays where bendingmoment load is greatest, a more uniform distribution of stress is obtained. Reinforced bridges carry more load for bridge parts used in their assembly than do standard bridges. Short spans of SS, DS, DT, and TT are limited in capacity by shear in end bays. They cannot be strengthened by local reinforcement of center bays and are not included in capacity tables 14–1 and 14–2.

14–2. Reinforcement With Partial Story

a. Description. DS, TS, DD, and TD bridges, not limited by end shear (para 14–1), can be strengthened by converting the center portion to spans DD, TD, DT, and TT, respectively. The number of bays converted depends on the increase in load class. Added panels must be complete with bracing frames and tie plates: in triple-story assembly, overhead bracing is also necessary.

b. Assembly and Launching. Partial stories can be added before or after launching. When added before launching, use standard launching nose for complete bridges of the heavier assembly if the length of reinforcement is more than half the span. If the length of reinforcement is half the span or less, use launching nose for standard bridge of the lighter assembly.

c. Class. Table 14–1 gives safe classes of bridges reinforced with partial stories. Length of reinforcement and the class of each unreinforced bridge are also shown. Caution classes are all 25 percent greater than the safe values.

14–3. Reinforcement With Supplementary Chords

a. Description. All types of bridges except spans limited by end shear can be reinforced with supplementary chords cut from damaged panels. The supplementary chords are pinned together and bolted to existing top and bottom chords with chord bolts. Bracing frames, modified to clear the chord bolts, must be used (fig 14–1). Overhead bracing supports cannot be used with supplementary chords unless bolts 4 inches longer than standard chord bolts are used. If overhead bracing supports are not used, overhead transoms can be clamped under the top chord or welded on top of the supplementary chords.

b. Special Parts.

(1) *Supplementary chords (fig 14–1).* Supplementary chords cut from salvaged panels must be straight and undamaged. The web channels must be burned off and ground smooth without damaging the chord channels. To use lower panel chords as top-chord reinforcement on all types of bridges, transom seats must also be carefully removed and ground smooth. A supplementary chord weighs about 200 pounds.

(2) *Modified bracing frame (fig 14–1).* Horizontal bracing frames on double- and triple-truss bridges reinforced with supplementary chords must be modified to clear the projecting chord bolts. A tube, 1½ inches long and between 2¾ inches and 3¼ inches internal diameter, is welded into each longitudinal angle 8 7/16 inches from the bolt holes at one end of the frame. An improvised jig should be used to hold the bracing frame during cutting and welding to maintain alinement of the bolt holes. This modification does not prevent normal use of the bracing frame.

c. Assembly and Launching. Supplementary chords cannot be added to the lower chord before launching because projecting chord bolts interfere with rollers. They can be added to upper chords, however, with no change in standard launching noses. Bracing bolts for fastening horizontal bracing frames must be inserted in supplementary chords before the chords are bolted to the truss. When chord bolts are tight, nuts are removed from the bracing bolts, and bracing frames added (fig 14–1).

Table 14-1. Classes of Bailey Bridge M2 (Reinforced with Partial Stories)

Type of construction	DS		TS		DD		TD	
Simple spans (ft)	No. of bays reinf	Class	No. of bays reinf	Class	No. of bays reinf	Class	No. of bays reinf	(
90	0 3	35/40 40/45	0 5	65/65 70/75				
100	0 6	30/30 35/45	0 4 6	50/55 55/60 65/70	0 4	80/80 90/90		
110	0 7	20 35/40	0 5 7	35/40 45/55 55/65	0 5 7	65/70 75/80 80/90*		
120	0 6 8	16 24 30/35	0 6 8	30/35 40/45 55/60	0 6 8	45/55 70/75 75/85	0 4 6	6 7 100
130	0 7 9	12 20 30/30	0 7 9	20 35/40 50/55	0 5 7 9	35/45 40/50 60/65 65/70	0 5 7	5 7 9
140	0 8 10	8 16 24	0 8 10	16 30/55 40/45	0 6 8 10	30/35 35/40 50/60 65/65	0 6 8	4 6 8
150			0 9 11	12 24/30 35/40	0 7 9 11	24 30/35 45/55 60/60	0 7 9 11	3 4 7 8
160			0 8 10 12	8 12 20 24/30	0 8 10 12	16 24/30 40/50 50/50	0 8 10	3 4 6
170					0 9 11 13	12 20 35/40 40/45	0 9 11	 3 0
180					0 10 12 14	8 12 30/35 35/40	0 10 12	 3 5
190							0 11 13	 2 4

Notes.
1. Grillage must be checked to make certain it will carry increased load.
2. *Limited by roadway width.
3. Upper figure represents wheel load class.
Lower figure represents track load class. *Example* 45/50
4. Bridges which have a normal rating over Class 70 must be assembled with double transoms.
5. Single classification is designated below Class 30.

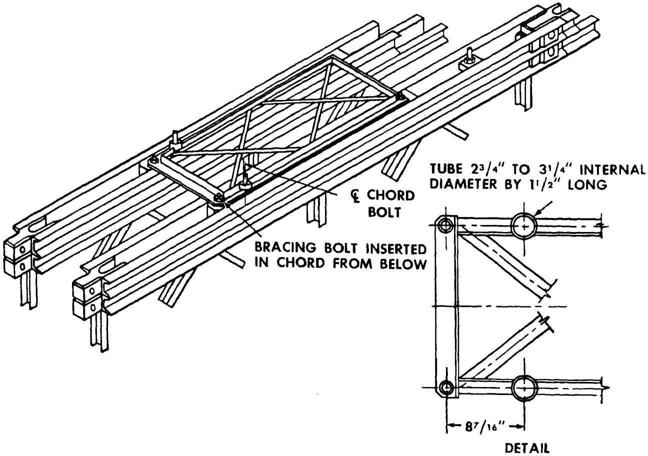


Figure 14–1. Supplementary chords and modified bracing frame.

d. Class. Table 14–2 gives the maximum safe class of bridges reinforced with supplementary chords and the corresponding length of reinforcement required. Caution classes are 25 percent greater than the safe values.

Table 14-2. Classes of Bailey Bridge M2 (Reinforced With Supplementary Chords)

Span (ft)	SS		DS		TS		DD		TD		DT		TT	
	Bays reinf	Class [2]	Bays reinf	Class [2]	Bays reinf	Class [2]	Bats reinf	Class [2]	Bays reinf	Class [2]	Bays reinf	Class [2]	Bays reinf	Class [2]
80	0	16	0	50 / 55	0	85 / 80								
	4	20	4	65 / 60	4	100* / 90*								
90	0	12	0	40 / 45	0	65 / 65								
	5	16	5	55 / 55	5	95 / 85								
100	0	8	0	30 / 30	0	50 / 55	0	80 / 80						
	6	16	6	45 / 50	6	80 / 75	4	100* / 90*						
110			0	20	0	35 / 40	0	65 / 70						
			7	45 / 45	7	70 / 70	7	100* / 90*						
120			0	16	0	30 / 35	0	45 / 55	0	75 / 80				
			8	40 / 40	8	65 / 65	8	100* / 90*	6	100* / 90*				
130			0	12	0	20	0	35 / 45	0	55 / 60				
			9	35 / 35	9	55 / 60	9	90 / 85	7	95 / 90*				
140			0	8	0	16	0	30 / 35	0	45 / 55				
			10	30 / 30	10	45 / 50	10	80 / 70	8	85 / 90*				

See footnotes at end of table.

Table 14-2. Classes of Bailey Bridge M2 (Reinforced with Supplementary Chords)—Continued

Span (ft)	SS		DS		TS		DD		TD		DT		TT	
	Bays reinf	Class [2]	Bays reinf	Class [2]	Bays reinf	Class [2]	Bays reinf	Class [1]	Bays reinf	Class [2]	Bays reinf	Class [2]	Bays reinf	Class [2]
150					0	12	0	24	0	35 45				
					11	40/45	11	70/65	9	80/85				
160					0	8	0	16	0	30 35				
					12	35/35	12	55/55	10	65/70				
170							0	12	0	20				
							11	45/45	11	55/65				
180							0	8	0	16				
							12	35/40	12	45/55				
190									0	12	0	30/35	0	45/55
									13	45/50	9	35/35	7	50/50
200											0	20	0	35/40
											10	30/30	10	45/45
210											0	16	0	24
											13	30/24	11	40/40

Notes.
1. Both upper and lower chords of bridge must always be reinforced.
2. Grillage must be checked to make certain it will carry increased load.
3. *Limited by roadway width.
4. Upper figure represents wheel load class.
Lower figure represents track load class. *Example* 45/50
5. Bridges which have a normal rating over Class 70 must be constructed with double transoms.
6. Single classification is designated below Class 30.

CHAPTER 15

CABLE REINFORCEMENT SET

Section I. DESCRIPTION OF THE SYSTEM

15–1. Use

The cable reinforcement set for panel bridge M2 (Bailey type) increases to class 60 wheel and track the classification of triple-single Bailey bridge for span lengths from 100 feet to 170 feet. For a span of 180 feet the class is 50 wheel and 60 track. This system significantly reduces the assembly time and equipment necessary to cross class 60 traffic over spans of between 100 and 180 feet.

15–2. Principle

The cable reinforcement set consists of a system of cables attached to each end of the bridge and offset from under the bridge by posts (fig 15–1). The cables are tensioned, causing the bridge to deflect upwardly. When a vehicle crosses the bridge, the bridge deflects downward, transferring part of the load into the cables.

15–3. Description

a. This paragraph describes the use of the cable reinforcement set with a panel bridge. Specific components of the set are described in paragraphs 15–6 through 15–24.

b. From two to six cables are slung under the bridge (table 15–1), half on one side of the bridge and half on the other side. They are connected to

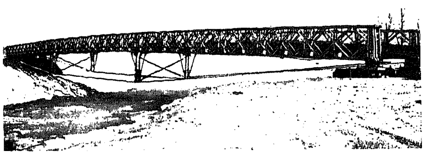


Figure 15–1. Cable reinforcement set installed on a 180-foot triple-single Bailey bridge (class 50/60).

the ends of the bridge by cable connectio The standard Bailey end posts on each tr be replaced by standard span junction order to install the cable connection be 15–2). The cables are held away from th of the bridge by two or four approximate vertical posts (fig 15–3). The number a ment of these posts depend on the bri length (table 15–1). The cables are the sioned to the cable tension given in ta The cables are tensioned by the cable te assembly consisting of double-acting l cylinders and a hydraulic power unit. T of hydraulic power units are used: ele hand. The electric unit (fig 15–4) is norm for installation of the system. Two are ne require one 10 kw or two 5 kw electric ge The hand-driven hydraulic pump is used to check cable tension (fig 15–5). C sions are read directly from a dial i cable tension gage mounted on either l power unit. The cables are tensioned i near bank only. The near bank end of th is called the "tensioning end." The fa called the "dead end."

c. Six cables are provided with the s cable is 179 feet 6 inches long. On the te end of the cable, a threaded stud is prov the dead end of the cable there are nine spaced approximately 10 feet apart sta feet from the stud end. This provides a cc of the cable at the dead end accordin bridge span length.

15–4. Transportation

The cable reinforcement set is transp three 5-ton dump trucks. One truck carrie assemblies and components (fig 15–6), th the cables (fig 15–7), and the third ca span junction posts (fig 15–8).

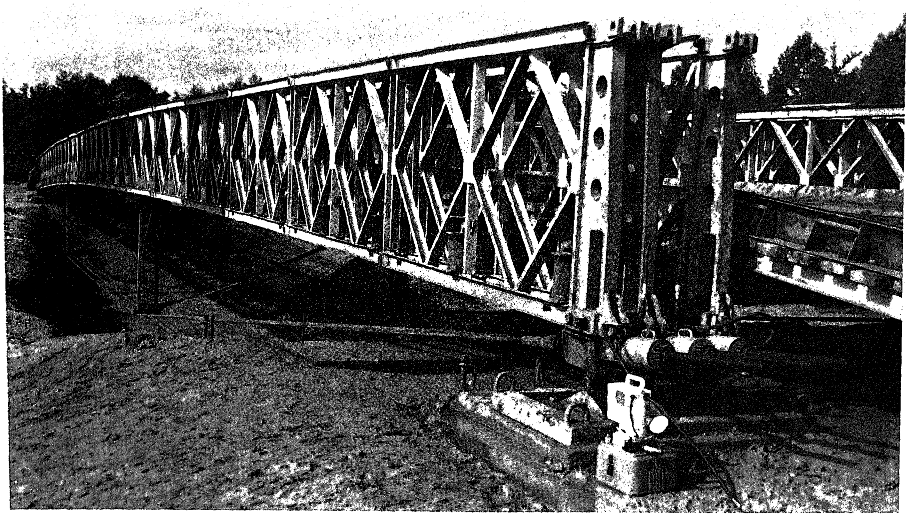


Figure 15–2. Span junction posts replacing standard end post on Bailey bridge with cable reinforcement set.

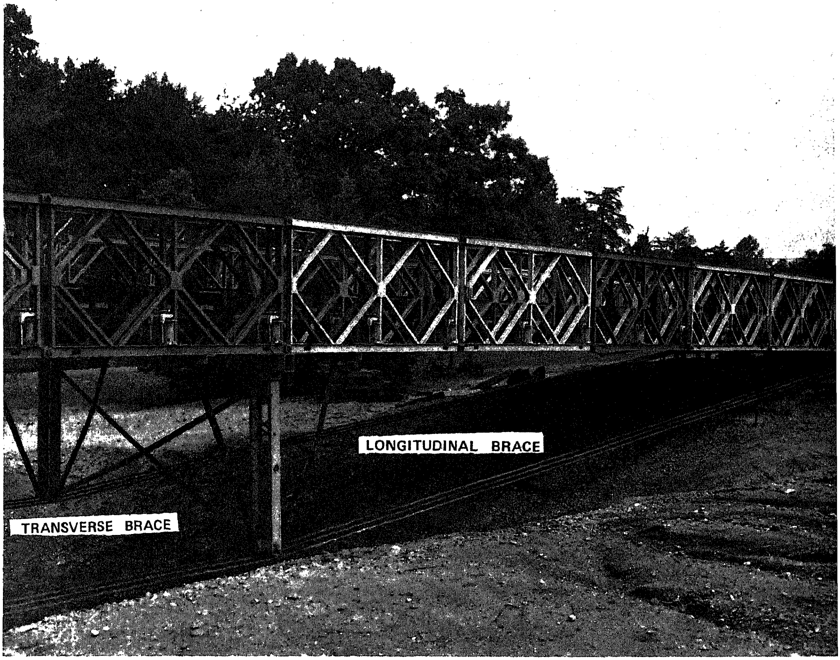


Figure 15–3. Cable reinforcement set vertical posts installed on Bailey bridge.

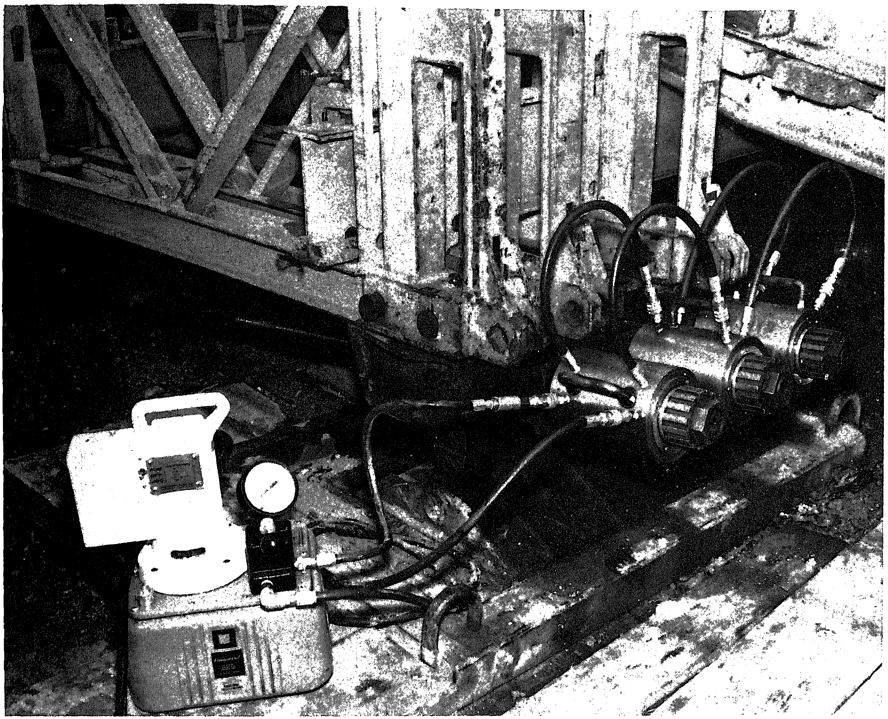


Figure 15–4. Cable tensioning assembly with electric hydraulic power unit.

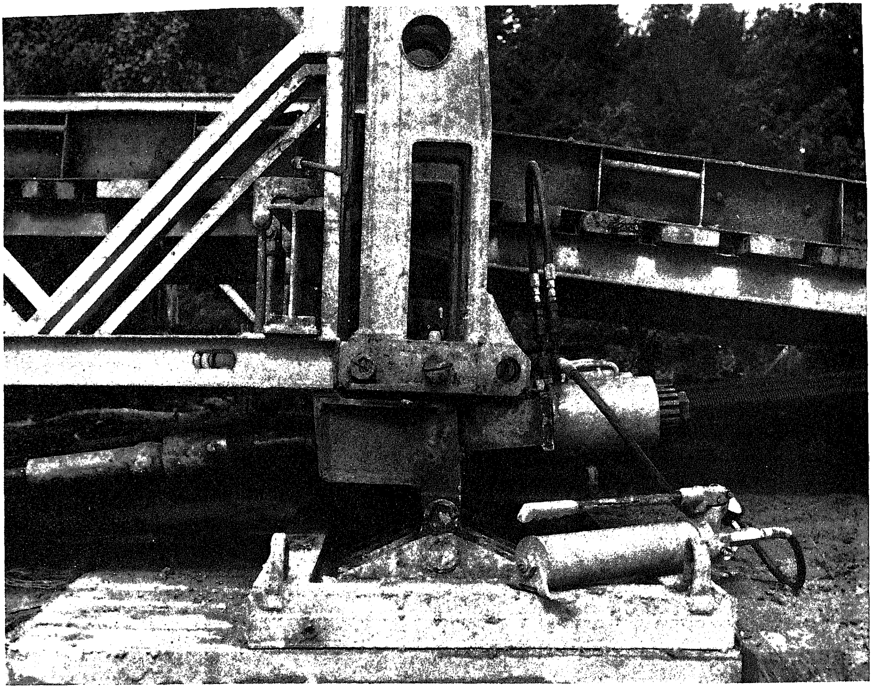
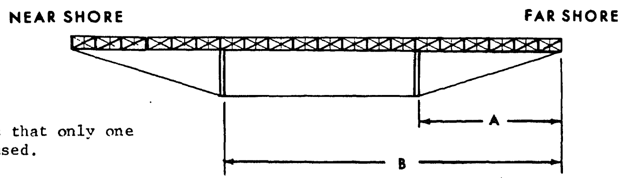


Figure 15–5. Cable tensioning assembly with hand-driven hydraulic pump used to check cable tensions.

Table 15–1. Data on Use of Cable Reinforcement Set

Span length	Number of cables required	Number of posts required (on each side of bridge)	Distance of posts from far shore		Cable tension (tons/cable)	Min upward deflection at midspan relative to support (in inches) (- downward deflection)
			A	B		
100	2	1	50'	0*	20	-2.0
110	2	1	55'	0*	36	-2.0
120	4	1	60'	0*	30	-2.0
130	4	1	65'	0*	36	0.0
140	6	1	70'	0*	28	4.0
150	6	2	60'	90'	32	8.5
160	6	2	60'	100'	38	12.5
170	6	2	60'	110'	46	18.5
180	6	2	60'	120'	44	17.5



* Indicates that only one post is used.

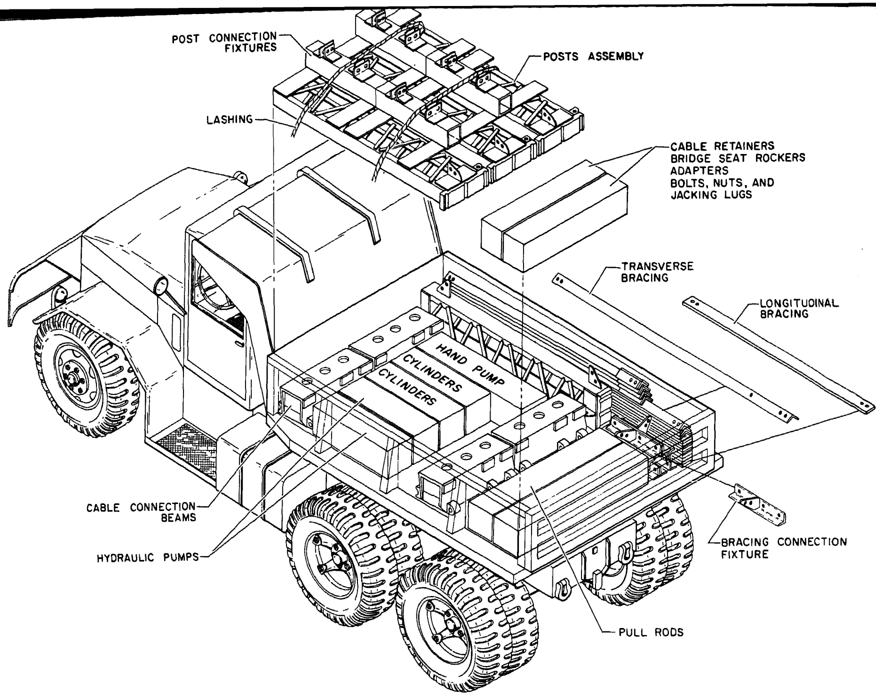


Figure 15–6. Set assemblies and components (excluding cable reels, cable reel supports, cable reel shafts, and span junction posts) stacked on body of M51 truck.

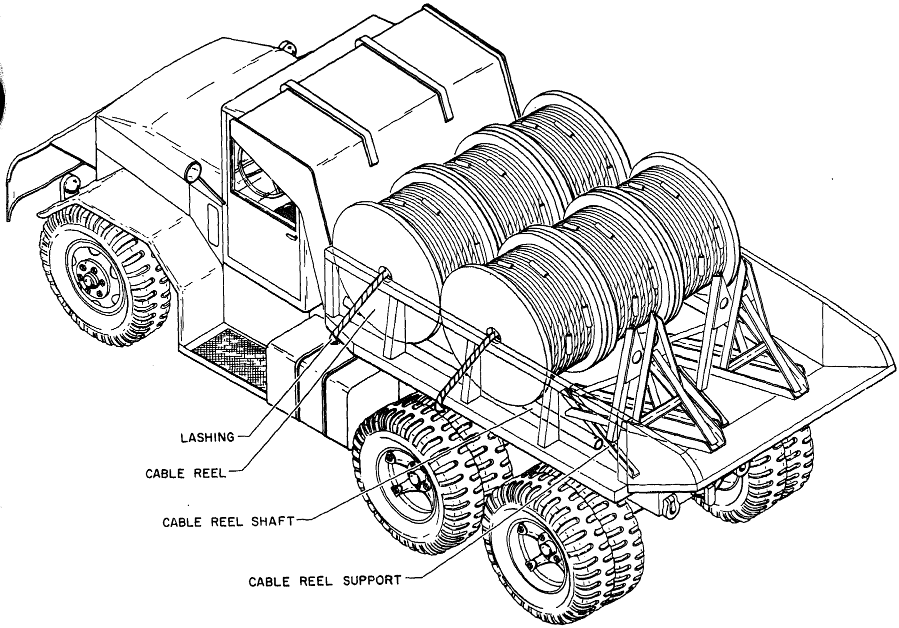


Figure 15–7. Cable reels, cable reel supports, and cable reel shafts stacked on body of M51 truck.

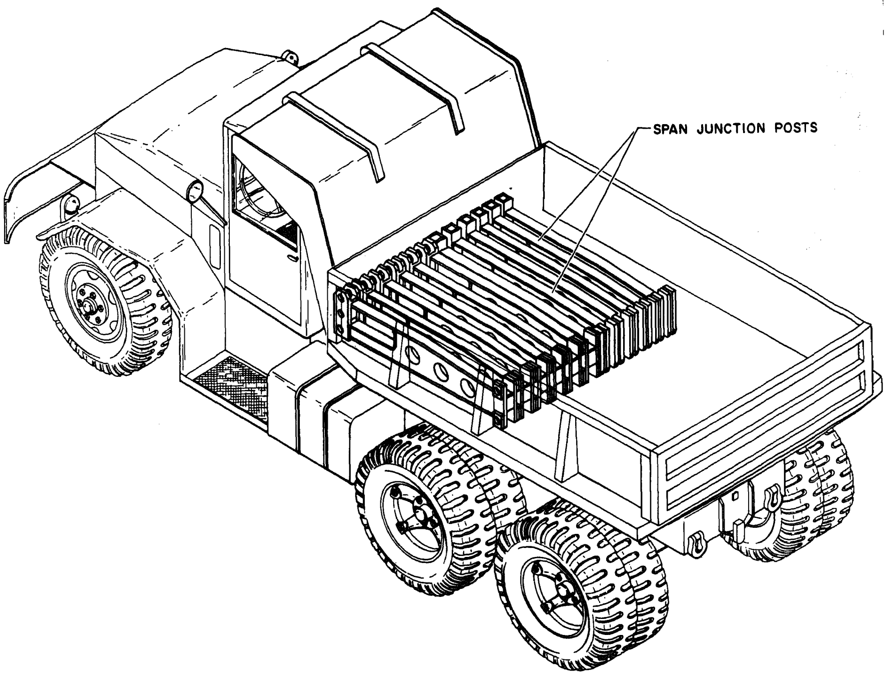


Figure 15–8. Span junction posts stacked on body of M51 truck.

15–5. Classification

The classifications in table 15–2 are obtained with the cable reinforcement set:

Table 15–2. Classification of Bridges Equipped with Cable Reinforcement Set

Span length	Normal crossing		Caution crossing		Risk crossing	
	Wheel	Track	Wheel	Track	Wheel	Track
100′ to 170′	60	60	70	70	75	75
180′	50	60	60	65	65	70

Section II. COMPONENTS

15–6. Introduction

The following assemblies and components comprise the cable reinforcement set. Description of these parts includes function and location.

15–7. Post Assembly

The vertical post assembly (fig 15–9) is a fabricated structural steel member which is suspended directly below a vertical member of the bridge panel. A saddle welded on the lower end of the vertical post provides a seat for the cables, and a cable retainer is bolted to this vertical post base to support the cables before they are tensioned. The post assembly is secured to the lower panel chord of the M2 Bailey bridge, as shown in figure 15–10, by the post connection fixture. The post assembly weighs 269 pounds.

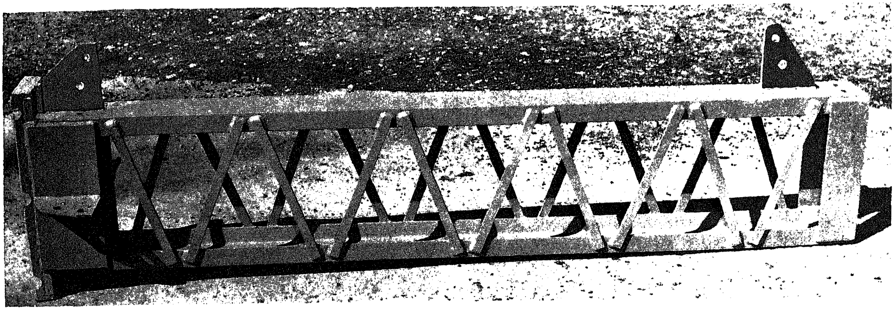


Figure 15–9. Vertical post assembly.

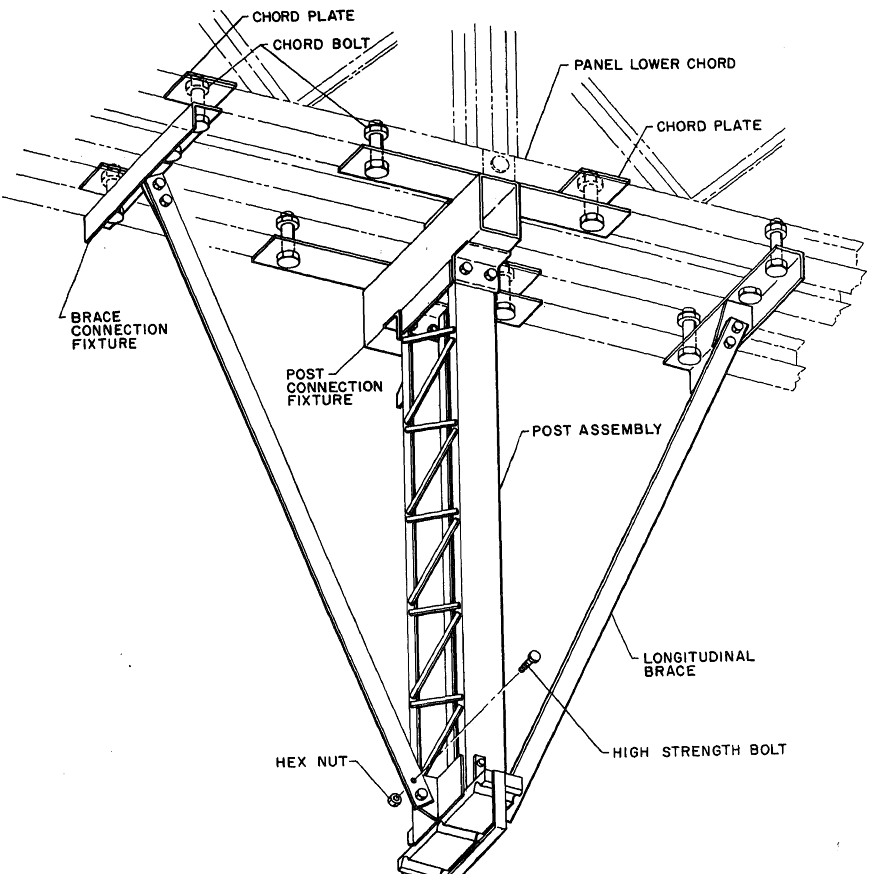


Figure 15–10. Vertical post, brace connection fixtures, and longitudinal braces secured to panel lower chord of M2 panel bridge.

15-8. Post Connection Fixture

The post connection fixture (fig 15-11) provides the connection between the post assembly and the bridge panel lower chord (fig 15-10). This fixture is secured to the panel lower chord by four bolts and hex nuts. Two chord plates are used on one side of the connection fixture to adapt the bridge panel for securing the fixture. The fixture weighs 178 pounds.

15-9. Brace Connection Fixture

Left-hand and right-hand brace connection fixtures (fig 15-12) secure braces, which support the post assembly, to the lower chord of the bridge panel. One brace connection fixture is secured to the panel lower chord by three bolts and hex nuts. The opposite brace connection is secured by the same hardware plus the addition of chord plates (fig 15-10) which are required to adapt the panel lower chord for securing this brace connection fixture. The fixture weighs 32 pounds.

15-10. Braces

There are two types of post braces, longitudinal and transverse (fig 15-13). The longitudinal braces are flat steel bars which are bolted to the brace connection fixtures and the lower end of the post assembly (fig 15-10). They are 8 feet 1/4 inch in length, 3 inches wide, 3/8 inch thick, and weigh 32 pounds each. Transverse braces are steel angles which are placed between posts on each side of the bridge(fig 15-14). These braces are bolted to welded plates on each end of the vertical posts. For convenience of storage and transportation, each transverse brace consists of two parts: a 7 foot 4 inch brace angle with a welded splice plate on one end and a 10 foot brace angle which is bolted to the splice plate of the shorter bracing. A high strength bolt and hex nut secure the two transverse braces together where they cross between post assemblies, as shown in figure 15-14. The total weight of one transverse brace is 88 pounds.

15-11. Chord Plate

The chord plate (fig 15-15) is used to adapt the bridge panel lower chord for securing the brace connection fixture and post connection fixture to the panel lower chord.

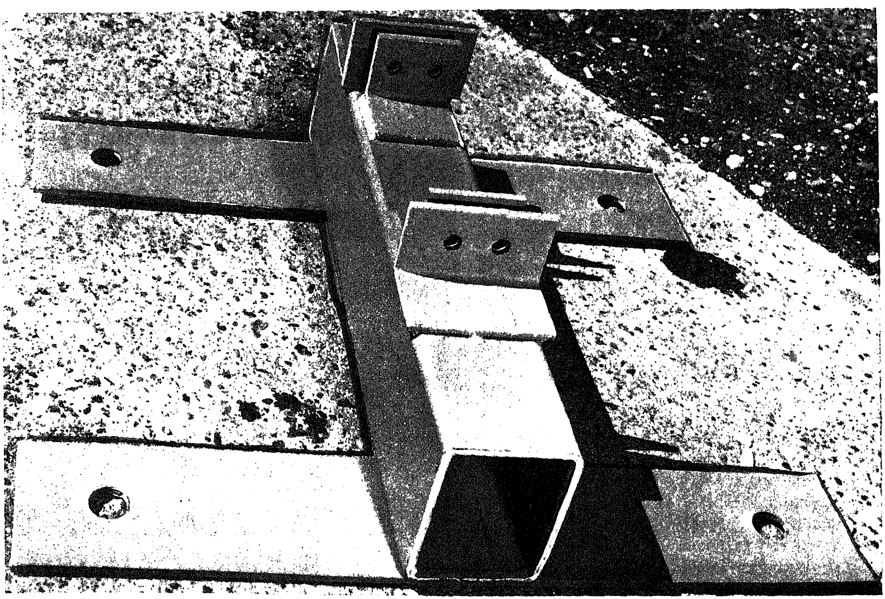


Figure 15-11. Post connection fixture.

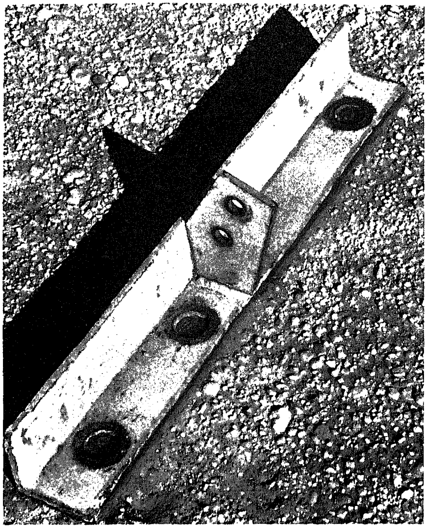


Figure 15–12. Brace connection fixture.

15–12. Cable Assembly

The cables (fig 15–16) are $1\frac{1}{4}$ inch diameter high-strength wire ropes with threaded stud on one end and nine buttons at specific intervals along the length of the cable. The first button is located approximately 100 feet from the stud end of the cable and the remaining eight buttons are spaced at approximately 10-foot intervals toward the opposite end. Each button is marked with the applicable length of the M2 panel bridge. The stud end of the cable is screwed into a rod-to-cable coupling (fig 15–17 and 15–18) and secured by a bolt-type setscrew The rod-to-cable coupling also has internal threads to retain the pull rod. The cables are 179 feet 6 inches long and weigh 595 pounds. They are wound on wooden cable reels for convenience of storage and shipping. The reels weigh 180 pounds each. Six cables come with the reinforcement set.

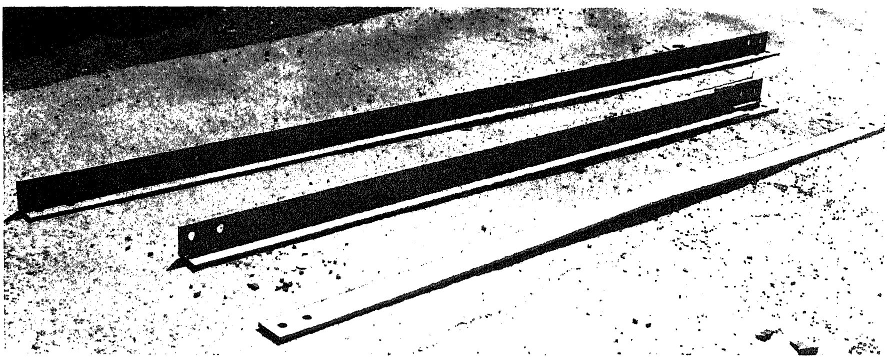


Figure 15–13. Longitudinal and transverse braces.

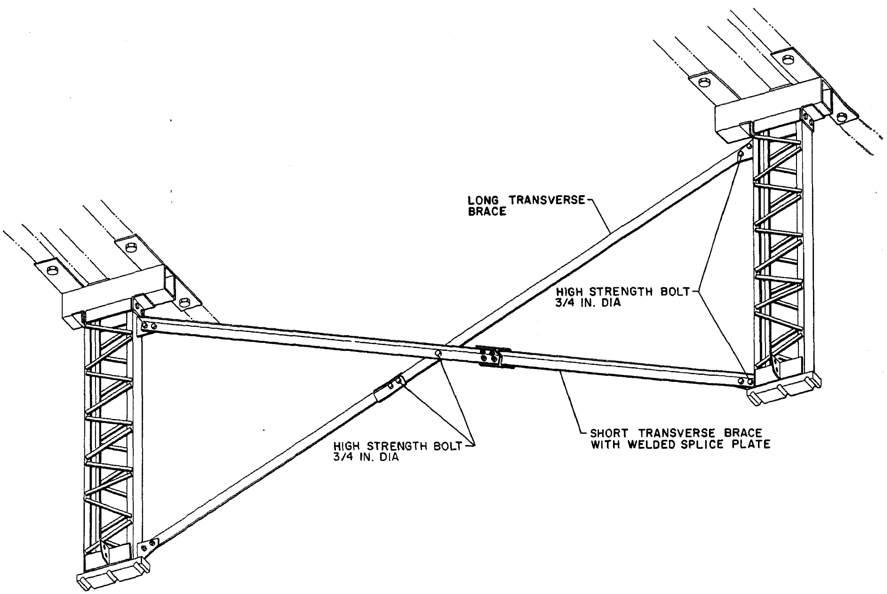


Figure 15–14. Transverse braces.

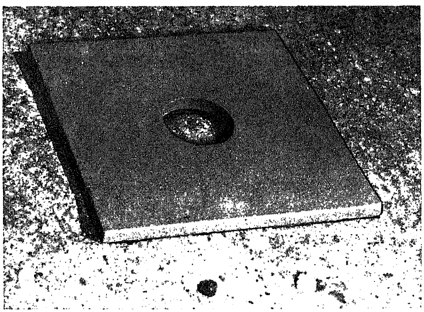


Figure 15–15. Chord plate.

15–13. Cable Reel Support

The cable reel supports (fig 15–19 and 15–20) are steel frames which support a cable reel shaft on which three cable reels are retained. The cable reel shaft is secured to each cable reel support by a bolt which is inserted through each end of the pipe shaft and secured by a nut. The cable reel support and cable reel shaft weigh 287 pounds. The shaft is 10 feet long.

Figure 15–16. Cable assembly.

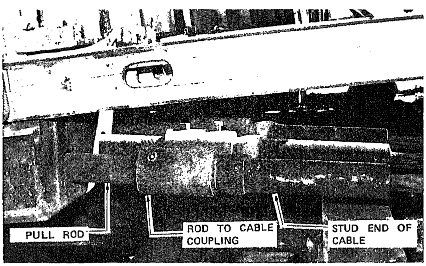


Figure 15–17. Rod-to-cable coupling.

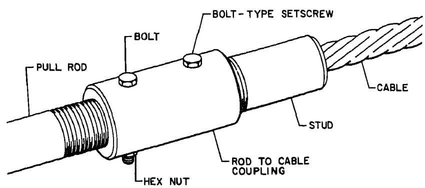


Figure 15–18. Cable stud end and pull rod in rod-to-cable coupling.

15–14. Cable Connection Beam

Left-hand and right-hand cable connection beams (fig 15–21) are steel frames which are secured to each corner of the M2 panel bridge, for connection and tensioning of the cables. These components are pinned to the bottom of span junction posts which replace the end posts of the M2 panel bridge. Each cable connection beam is a frame, with provisions for three cables with buttons or pull rods to pass through it. The cable connection beam weighs 315 pounds. These beams serve two purposes:

a. Dead-End Cable Connection Beam. After the cables, with buttons, are inserted through the holes provided in the cable connection beam, half cable retainers (fig 15–22) are placed between the bearing surface and the button to anchor the cable (fig 15–23).

b. Tensioning End Cable Connection Beam. After connection to the rod-to-cable couplings, the pull rods are fed through the cable connection beam and are retained by serrated nuts (fig 15–24). A double-acting hydraulic cylinder, when installed on each pull rod, bears against the front surface of the cable connection beam through the use of an adapter. The double-acting hydraulic cylinders are used to tension the cables (fig 15–25 and 15–26).

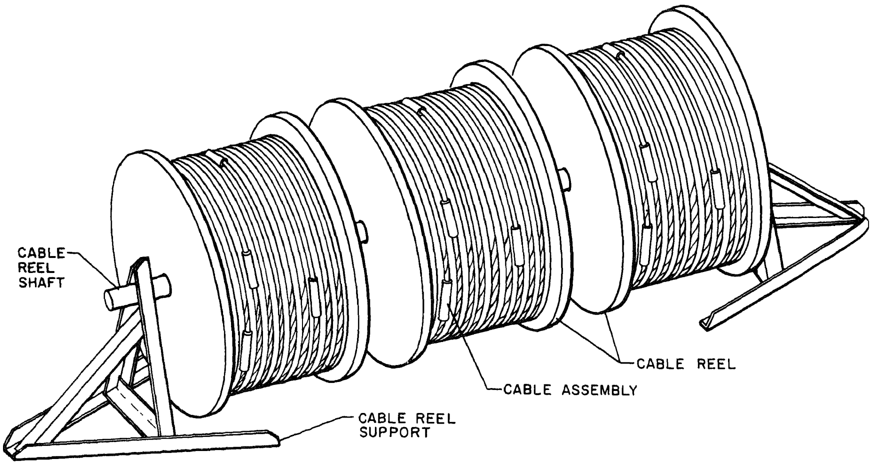


Figure 15–19. Cable assemblies installed on cable reels and cable reel supports.

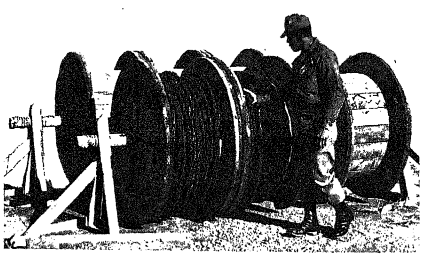


Figure 15–20. Cable reels mounted on cable reel supports.

15–15. Bridge Seat Rockers

Bridge seat rockers (fig 15–27) are placed between the bridge bearing and the cable connection beam at the tensioning end only (fig 15–28). The bridge seat rockers provide for longitudinal displacement that occurs while heavy traffic is crossing the bridge. Each rocker weighs 15 pounds.

15–16. Pull Rod Assembly

The pull rod assembly (fig 15–29) consists of a $2\frac{1}{4}$ inch high-strength threaded rod, a rod-to-cable coupling, and two serrated nuts. The assembly

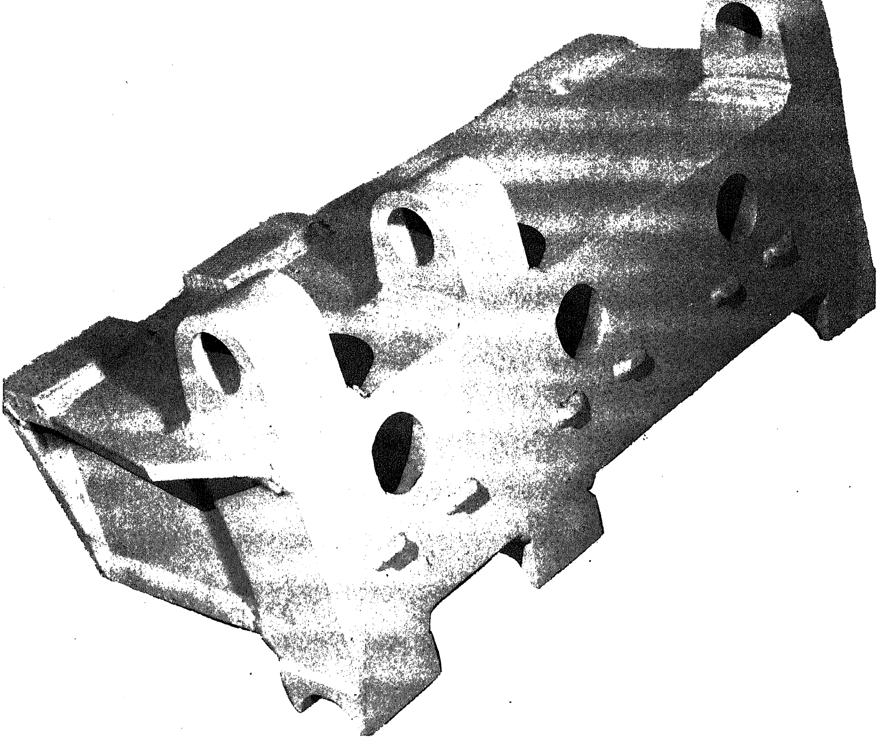


Figure 15–21. Left-hand cable connection beam.

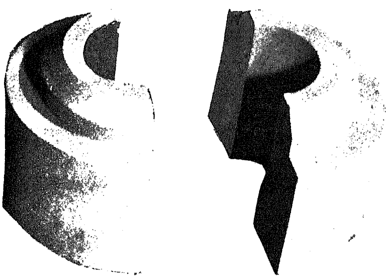
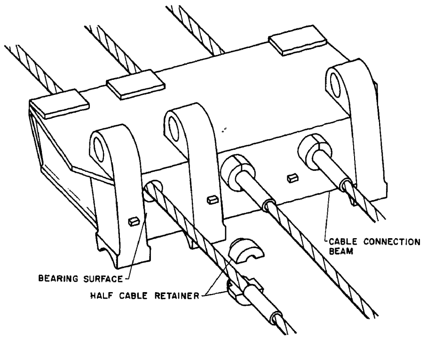


Figure 15–22. Half cable retainers.

provides for the connection of the cable to the cable connection beam on the tensioning end and serves as a means to tension the cables. One end of the pull rod is threaded into one end of the rod-to-cable coupling. The pull rod and rod-to-cable coupling are secured by a bolt and nut (fig 15–18). When the cable is tensioned, a serrated nut bears against the bearing surface of the cable connection beam to take the cable tension loads. The second serrated nut retains the double-acting hydraulic cylinder when it is installed on the pull rod (fig 15–32). The two serrated nuts are identical. The nut used to retain the cable is called the "cable nut" and the nut used to retain the double-acting hydraulic cylinder is called the "cylinder nut." The pull rod assembly is 5 feet 10 inches long and weighs 60 pounds.



Dead-End Cable Connection Beam

Figure 15–23. Half cable retainers placed between the cable connection beam bearing surface and the cable buttons to anchor the dead end.

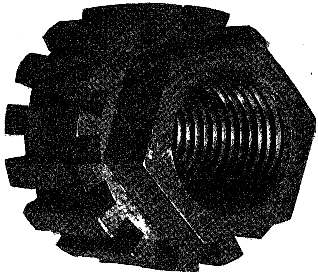
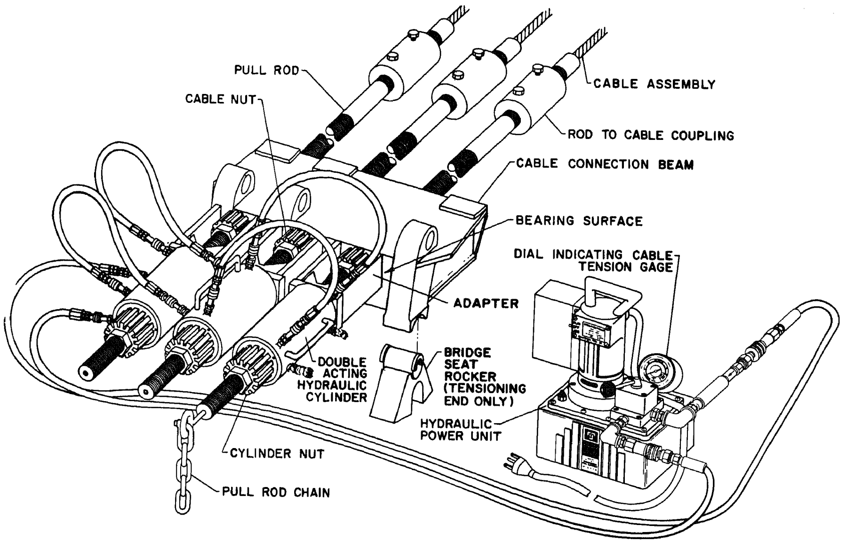


Figure 15–24. Serrated cable/cylinder nuts.



Jacking-End Cable Connection Beam

Figure 15–25. Cylinders installed on pull rods passing through cable connection beam.

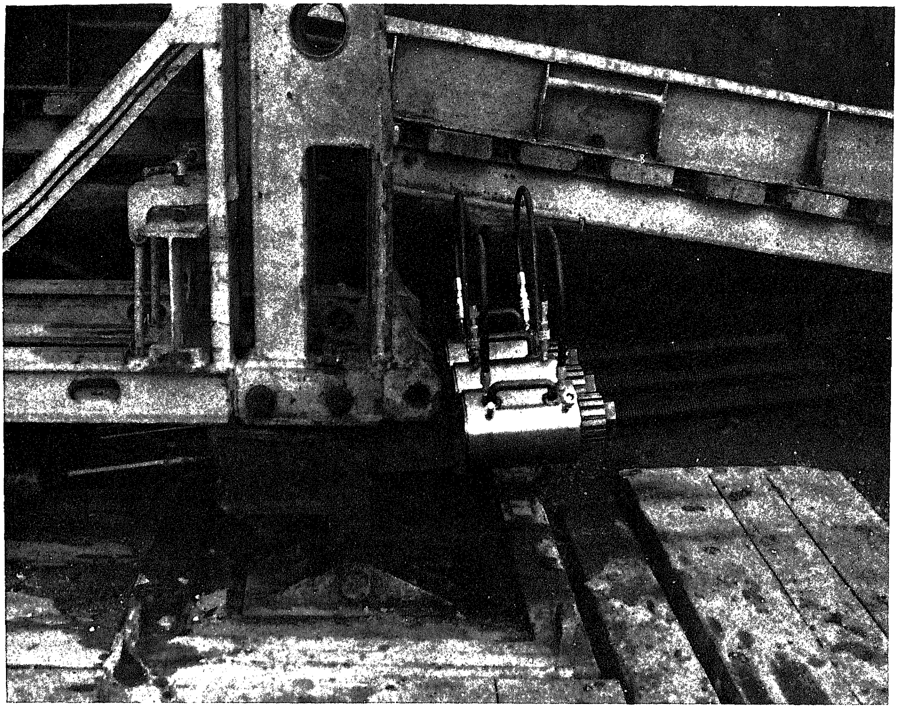


Figure 15–26. Double-acting hydraulic cylinders mounted on pull rods.

15–17. Pull Rod Chain

The pull rod chain (fig 15–25) is 12 feet long and screws into the end of the pull rod assembly after installation of pull rods in the cable connection beam. This pull rod chain assists in advancing the cable nut before installation of the hydraulic cylinders.

15–18. Adapter

An adapter (fig 15–30) is used during the cable tensioning procedure to take the cable tensioning load from the hydraulic cylinder until the cable nut is tightened. One adapter is used for each cable. The adapter weighs 20 pounds.

Figure 15–27. Bridge seat rocker.

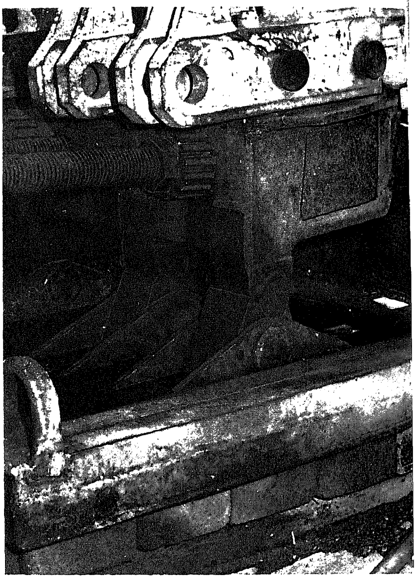


Figure 15–28. Bridge seat rockers in place between standard bearing and cable connection beam (tensioning end only).

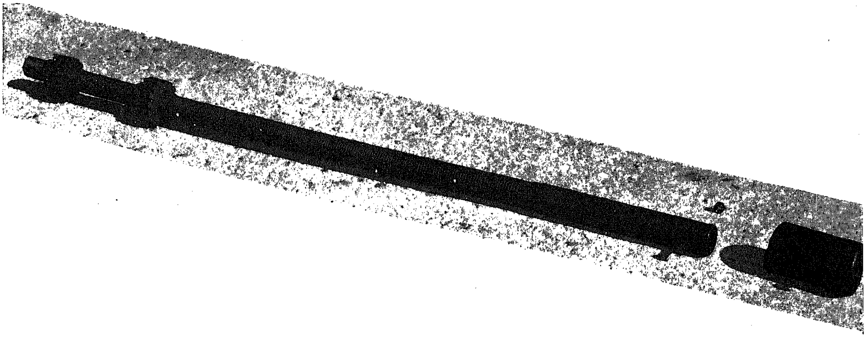


Figure 15–29. Pull rod assembly with rod, rod-to-cable coupling, lock bolt and screw, and serrated nuts.

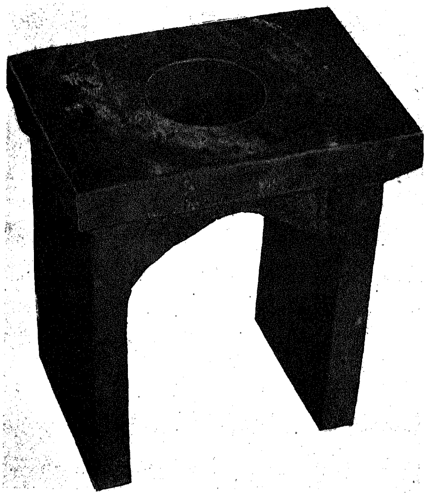


Figure 15–30. Adapter against which double-acting hydraulic cylinders bear during tensioning of the cables.

15–19. Cable Tensioning Assembly

The cable tensioning assembly is used to tension the cables. It has two basic components: (1) a hydraulic power unit assembly, and (2) double-acting hydraulic cylinders.

a. Hydraulic Power Unit Assembly. The hydraulic power unit assembly (fig 15–31) consists of a hydraulic power unit, gage, hose assemblies, quick disconnect couplings, and a flow regulator. The hydraulic power unit has a filler/vent plug for adding or removing hydraulic oil, an electric switch for controlling the amount of fluid flow, and a valve for controlling the direction of fluid flow. Two hydraulic power units are required for a bridge. Each weighs 65 pounds. They are powered by either one 10 kw generator or two 5 kw generators.

b. Hydraulic Cylinders. One double-acting hydraulic cylinder (fig 15–32) is required for each cable. A hole through the center of the cylinder allows installation of the cylinder on the pull rod. The power unit is used to expand and retract the cylinders. When the cylinder is pressurized to expand, it advances the pull rod through the cable connection beam increasing cable tension. Each cylinder weighs 65 pounds.

15–20. Hand-Driven Hydraulic Ram Pump

The hand-driven hydraulic ram pump (fig 15–5) is included in the kit to provide a means for periodic checking and adjusting of cable tension. It has an end dipstick/plug for checking and adjusting fluid level, a gage adapter, gage, hose assemblies with quick disconnect couplings, flow regulator, and a control valve to direct fluid flow to and from the cylinders.

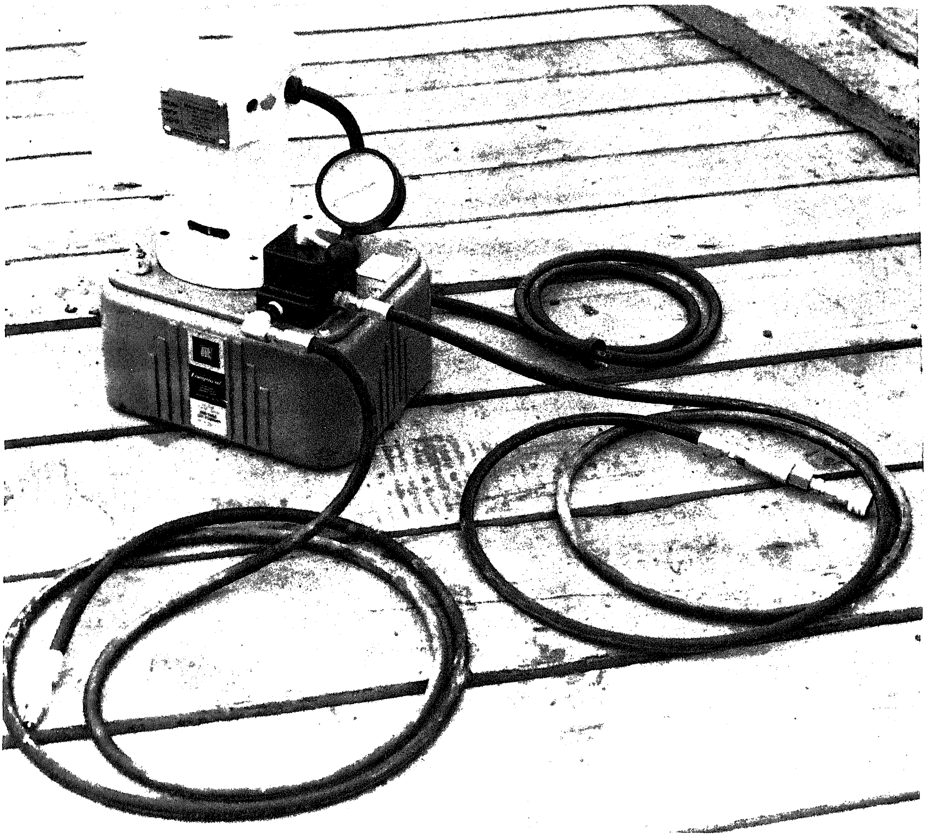


Figure 15–31. Hydraulic power unit assembly.

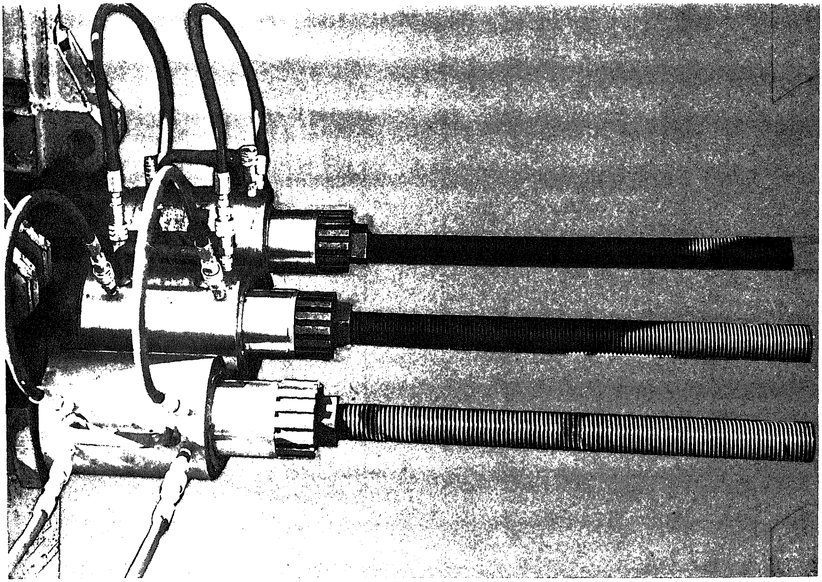


Figure 15–32. Double-acting hydraulic cylinders and adapters mounted on pull rods.

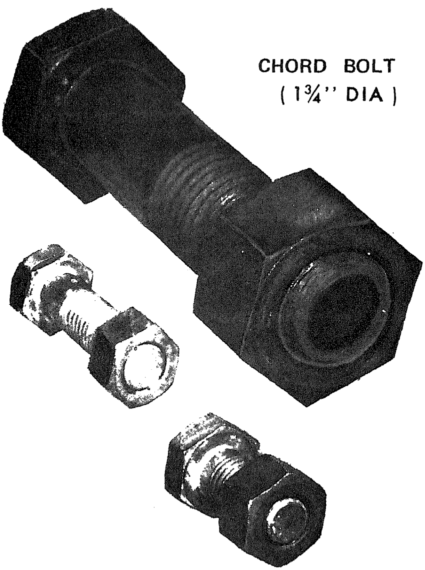


Figure 15–33. Bolts used in the cable reinforcement set.

15–21. Bolts

Three types of bolts (fig 15–33) are used to secure major parts of the cable reinforcement set together and to the M2 panel bridge: machine, chord, and high-strength bolts. Machine bolts secure parts in assemblies such as the cable reel shaft. Chord bolts secure fixtures to the panel lower chord. High-strength bolts secure bracings to the post assemblies. High-strength bolts are identified by radial lines embossed on the head.

15–22. Jacking Lug

Jacking lugs (fig 15–34), when pinned to the end holes of the span junction posts, provide a lifting surface for jacking up the bridge.

15–23. Span Junction Posts

Male and female span junction posts (fig. 15–35) from bridge conversion set No. 3, Bailey type, panel crib pier, fixed M2 are used in place of the standard end posts. The male post weighs 194 pounds and the female weighs 202 pounds.

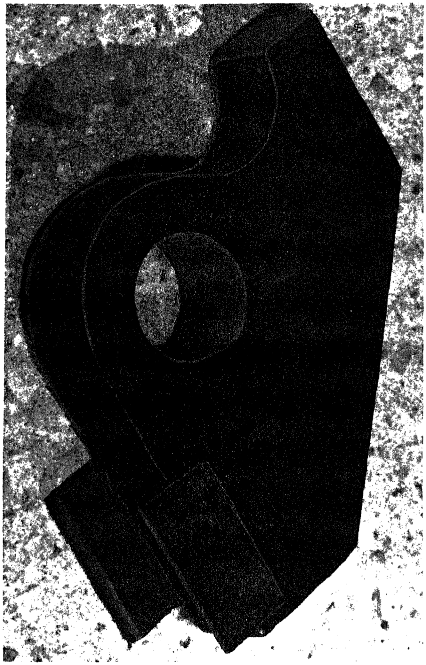


Figure 15–34. Jacking lug used with cable reinforcement set.

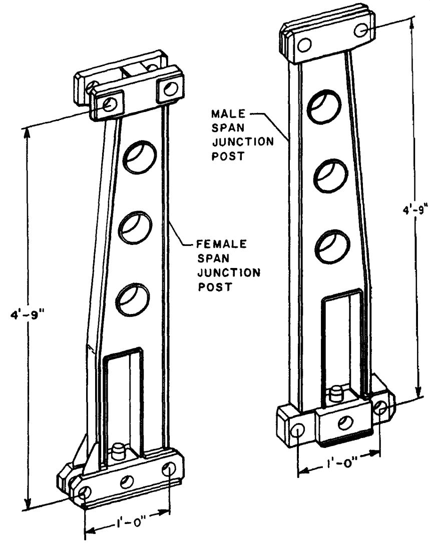


Figure 15–35. Span junction posts.

15–24. 2⅝-Inch Box Wrench

A special 2⅝-inch box wrench (fig 15–36) with an offset head is used to tighten the chord bolts inserted through chord plates. After the nut is tightened as much as possible by normal means, this wrench is used to tighten it an additional one-fourth turn by striking the end of the wrench with a sledge hammer.

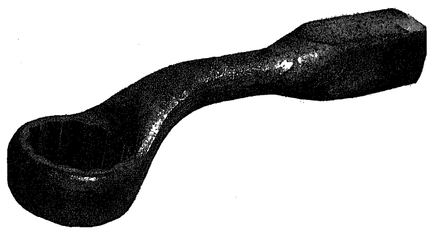


Figure 15–36. 2⅝-inch box wrench used to tighten brace connection fixtures to panel chords.

Section III. INSTALLATION AND DISMANTLING

15–25. Service Upon Receipt of Materiel

When new, used, or reconditioned materiel is first received by the using organization, it is necessary to determine whether this materiel has been properly serviced by the supplying organization, and whether it is in proper operating condition. Records should be kept on any missing assemblies or component parts and equipment. The following inspections and services should be performed for the cable reinforcement set before any installation procedures:

a. Remove any cushioning material or protective covers from the packaged cable tensioning assemblies and pull rod assemblies.

b. Perform preventive maintenance checks and services as required, in accordance with table 15–3.

c. Visually inspect the cable tensioning assembly for any leakage or damage which would limit effective operation.

15–26. Installation Concurrent With Assembly of Bridge

a. Placement of Materiel.

(1) The contents of the trucks which carry all assemblies and component parts (except the cables and cable reels) are unloaded and stacked in the vicinity of the end posts in the M2 panel bridge standard layout.

(2) Three cable reels with cables, which are retained on the cable reel supports, are placed on each side of the roadway at the rear of the bridge erection site. Cable reels should be removed from the bed of the truck using a crane or gin poles. Erection of cable reel supports is as follows:

(*a*) Place three unloaded cable reels side by side.

(b) Insert cable reel shaft through center hole of cable reels.

(*c*) Lift one end of cable reel shaft, close to cable reel, and slide cable reel support on cable reel shaft. Repeat for other end of cable reel shaft.

b. Post Assembly. Post assemblies are attached to the lower panel chords of the bridge according to table 15–1. To install each vertical post, proceed as follows:

Caution. **In order to install a post assembly correctly, the post connection fixture must be installed directly beneath the vertical member**

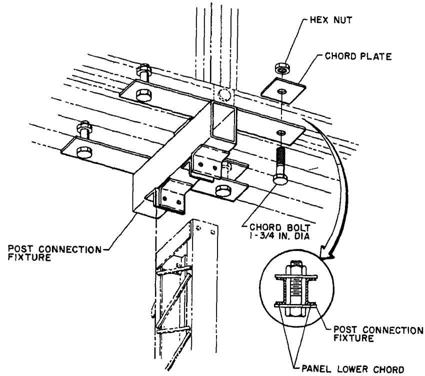


Figure 15–37. Post connection fixture bolted to panel lower chord.

beween two panels (from now on referred to as the panel point).

(1) When the panel point has sufficiently cleared the rocking roller, position the post connection fixture directly beneath the panel point.

(2) Secure the post connection fixture to the bridge panel lower chord using four 1¾-inch diameter chord bolts and hex nuts (fig 15–37). Tighten bolts firmly. The bolts on one end of the post connection fixture are placed in the holes normally used for adding second or third stories tiers to the Bailey bridge. The other end is secured by placing two chord plates on top of the lower chords using two 1¾-inch bolts and hex nuts (detail, fig 15–37).

(3) When a point approximately 4 feet behind the panel point has cleared the rocking rollers, install the brace connection fixtures. Position the large holes in the brace connection fixtures approximately 3 feet 9 inches ahead of and behind the panel point as shown in figure 15–38. On one side, the holes will line up with the holes in the lower chord used for multistory construction. Secure the brace connection fixture by placing chord bolts through these holes and tightening the hex nuts. On the other side, use two chord plates and bolt through the panel lower chords. Place bolt with nut on top of chord plate. Tighten nut enough to secure brace connection fixture but allow for adjustment later.

(4) When a minimum of 8 feet of clearance is available below the panel point, install the vertical post. Remove the cable retainer from the

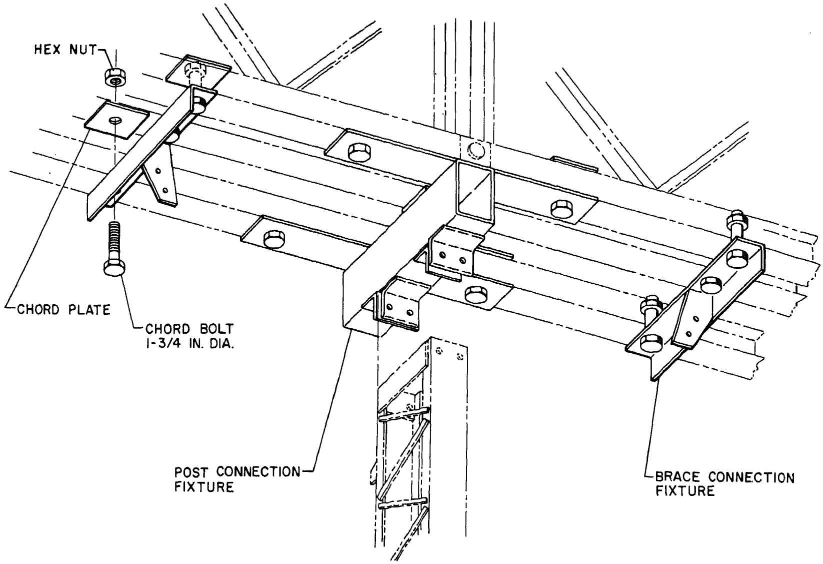


Figure 15–38. Brace connection fixtures bolted to panel lower chord.

vertical post and lower the post over the side of the bridge using ¾-inch hemp rope. Secure the vertical post to the post connection fixture using four ¾-inch diameter high-strength bolts and hex nuts (fig 15–39).

Caution. **All personnel who are lowered over the side of the bridge in a boatswain's chair must also wear a safety belt connected to lashings which, in turn, are secured to the side of the bridge.**

(5) Secure one longitudinal brace to the plate weldment of the brace connection fixture with two ¾-inch diameter high-strength bolts and hex nuts. Bolt the opposite end of the longitudinal brace to the plate weldment on the bottom end of the vertical post, using two high-strength bolts and hex nuts (fig. 15–10).

(6) Secure the second longitudinal brace to the plate on the brace connection fixture which is secured with chord plates, with two ¾-inch diameter high-strength bolts and hex nuts. Attach the opposite end of the brace to the plate weldment on the lower end of the vertical post using the same hardware. A small adjustment in the position of this longitudinal brace connection fixture may be necessary to complete the installation of the second longitudinal brace. Once the brace connection fixture is positioned, tighten the chord bolts through the chord plates using a 2⅝-inch box wrench having an offset head. Turn the nut on the bolt threads one-fourth turn, from the point where a person can no longer tighten the bolt by applying hand pressure to the wrench, by striking the wrench with a sledge hammer (fig 15–40) to complete installation of the longitudinal braces (fig 15–41).

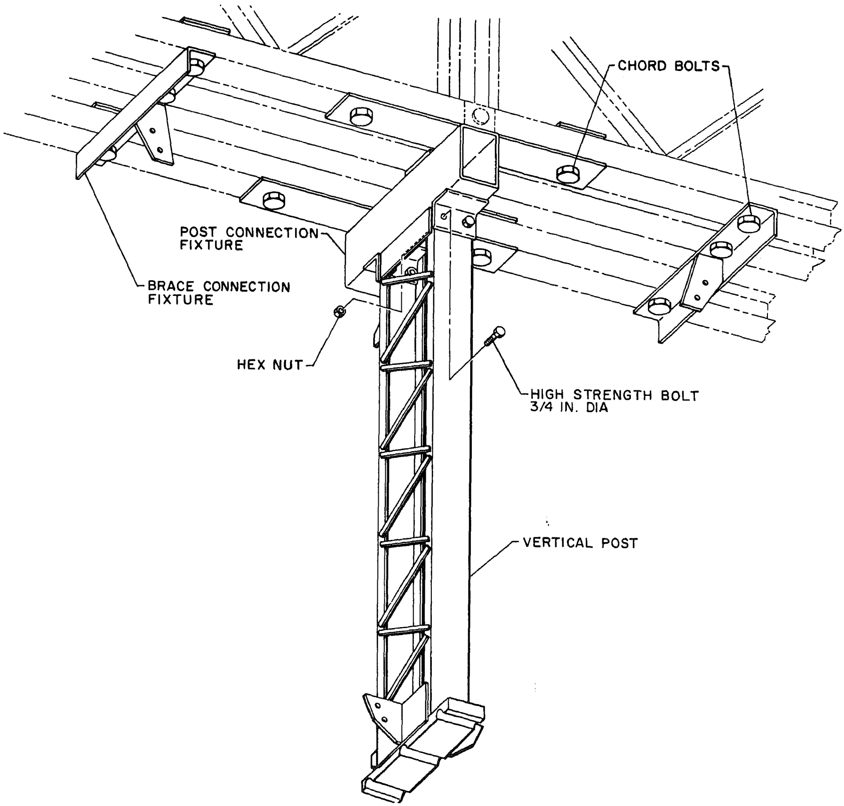


Figure 15–39. Vertical post bolted to post connection fixtures.

(7) Connect the long transverse brace to the short transverse brace, which has a welded splice plate, with four ¾-inch diameter high-strength bolts and hex nuts to form a full-length transverse brace. Repeat this procedure to form all full-length transverse braces. Connect two transverse braces to plates on each end of the vertical posts to form an X-type bracing. Each end of the transverse braces is secured to the vertical post weldment plates by two ¾-inch high-strength bolts and hex nuts. Bolt the two transverse braces together where they cross by installing a 3/4-inch diameter high-strength bolt and hex nut through the hole provided in the braces (fig 15–14 and 15–42).

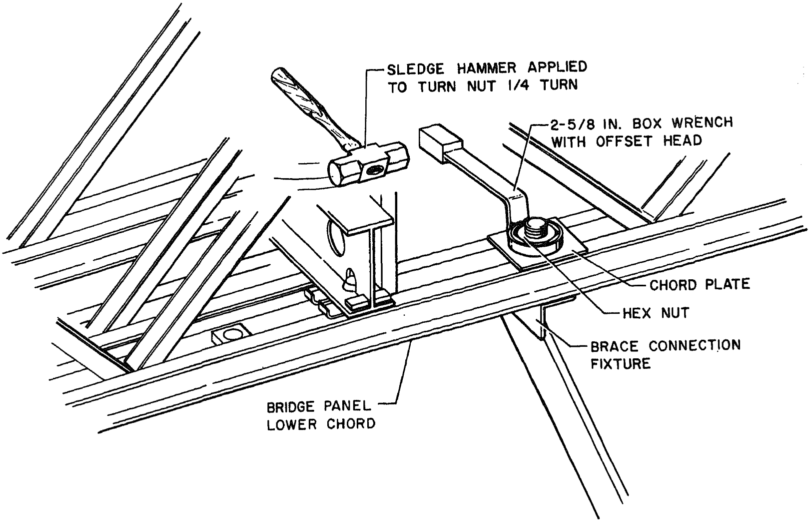


Figure 15–40. Sledge hammer applied to end of offset-head box wrench to turn nut ¼ turn.

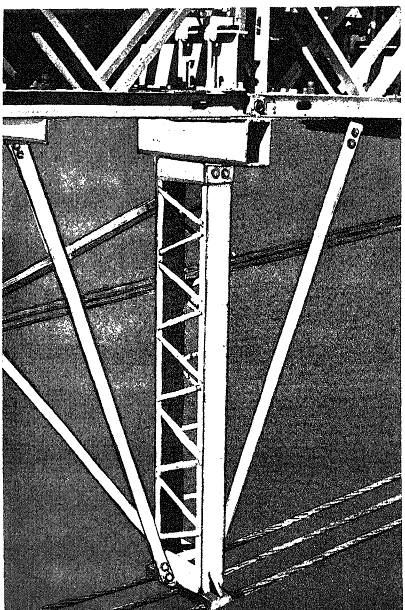


Figure 15–41. Vertical post with longitudinal braces installed.

***Caution.* This bolt provides a stabilizing func tion for the transverse braces. Do not forget t install it. Omission of this bolt could result i damage to the equipment.**

c. Preliminary Positioning of Cables Befor Launching Bridge. The total number of cable used depends on the bridge span; table 15–1 give the number needed for various spans. The re quired cables are placed in a preliminary positio on the bridge structure before launching th bridge, using the following procedure:

(1) Unwind one cable at a time from th cable reels, button end first.

(2) Loop a 16-foot length of ¾-inch diamete hemp rope to the cable at 20-foot intervals. A loo should be made at each end of the rope to facili tate the carrying and lashing of the cable (fi 15–43). Using these ropes to support the cabl carry the cable onto the bridge.

(3) When cable button number 180 is at th panel which will be the end panel on the far shor lash the cable to the panels.

(4) Repeat steps (1) through (3) above fo each cable on each side of the bridge. If thre cables are installed on each side of the bridge, th cable to be installed in the inner slot of the vert cal post saddle should be lashed to the lower pa of the bridge panels. The cable for the center sa dle slot should be lashed to the middle of th panels and the outside cable lashed to the top pa of the panels.

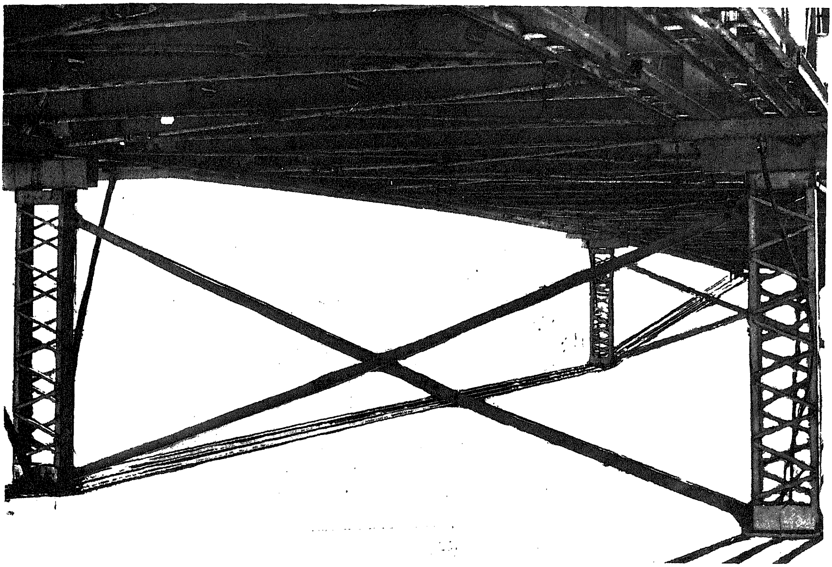


Figure 15–42. Transverse bracing connected to vertical posts.

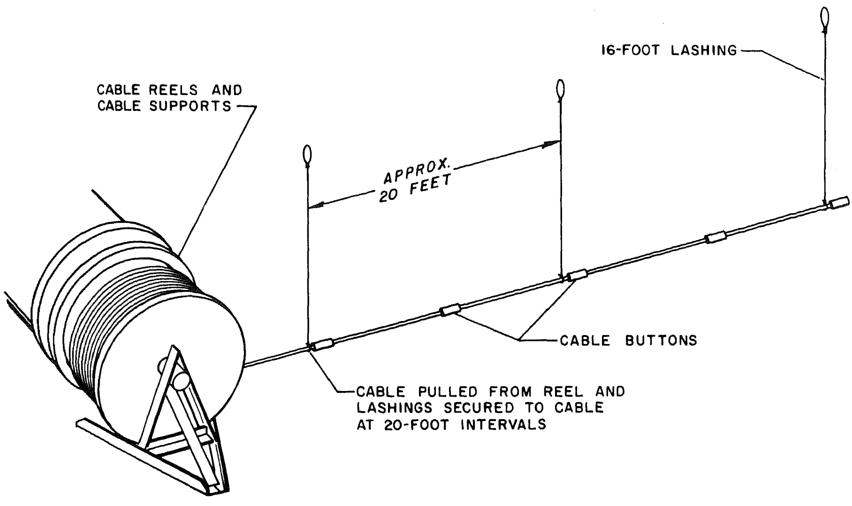


Figure 15–43. Unwinding cable from cable reel and installing rope lashings.

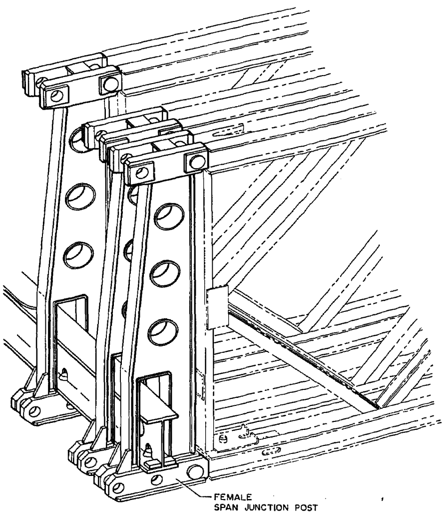


Figure 15–44. Span junction posts installed on end of M2 panel bridge.

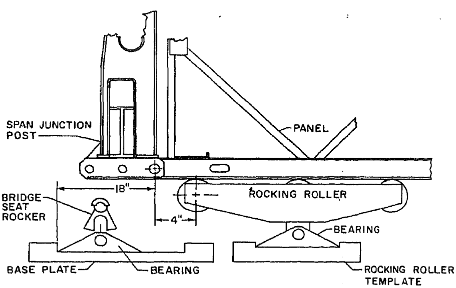


Figure 15–45. Final bridge adjustment and positioning of base plate.

d. Span Junction Posts. Just before final positioning of the bridge, install female span junction posts on one side of the bridge. Then insert a transom through the holes in the female span junction posts and push through hole until the flange of the transom hits the side of the female span junction posts. Next, install female span junction posts on the other side. Position the transom properly on the studs of the six female span junction posts (fig 15–44).

e. Positioning of Bridge Bearing Plate. Position the bridge so that the centerline of the first panel pin, through the bottom of the span junction post, measures 4 inches to the centerline of the outer rocking roller (fig 15–45). Then place the back inside edge of the base plate approximately 18 inches behind the centerline of the first panel pin. On the tensioning end of the bridge, a special bridge seat rocker (fig 15–27) must be placed over each bearing to allow longitudinal displacement of the bridge under load (fig 15–45).

Note. When the bridge is jacked down, the bearing shoe on the bottom of the installed cable connection beam will mate the bearings on the base plate or the rockers on bearings.

f. Jacking Up the Bridge. Install two jacking lugs (fig 15–34) at each bridge corner, one on the end hole of the outside span junction post and one on the end hole of the inside span junction post, using panel pins (fig 15–46). Install railroad jacks and jack up the end of the bridge to facilitate the installation of the cable connection beams. Use normal bridge installation procedure for removal of rocking rollers and templates, and use cribbing under the lower chord for safety, in case the bridge slips off the jacks.

g. Cable connection Beam Installation. Position the cable connection beams on the bridge seat rockers (tensioning end only) or bearings (dead end) under the raised span junction posts. Using normal jacking procedure, lower the bridge onto the cable connection beams until the holes in the beam lugs aline with the lower center holes in the span junction posts (fig 15–47). Secure the cable connection beams to the span junction posts using a set of standard panel pins. Secure the panel pins with safety pins. Complete jacking the bridge down onto the bearings (fig 15–48) and continue with normal procedure for standard installation of the bridge.

***Caution.* It is essential that both near- and far-shore abutment cribbings be level transversely with each other in order to eliminate eccentric loading causing bridge elements to be stressed beyond their capacity. It should also be noted that the bridge seat rockers will cause the tensioning end to be higher by the installed height of the rockers.**

h. Installation of Cable. After the bridge has been decked, install all cables using the following procedure for each cable:

(1) Remove lashing ropes from side panels of the bridge but not from the cable. Using the ropes to support the cable, thread button number 180 and the following cable through the dead-end cable connection beam. If only two cables are used, one on each side, each cable is threaded

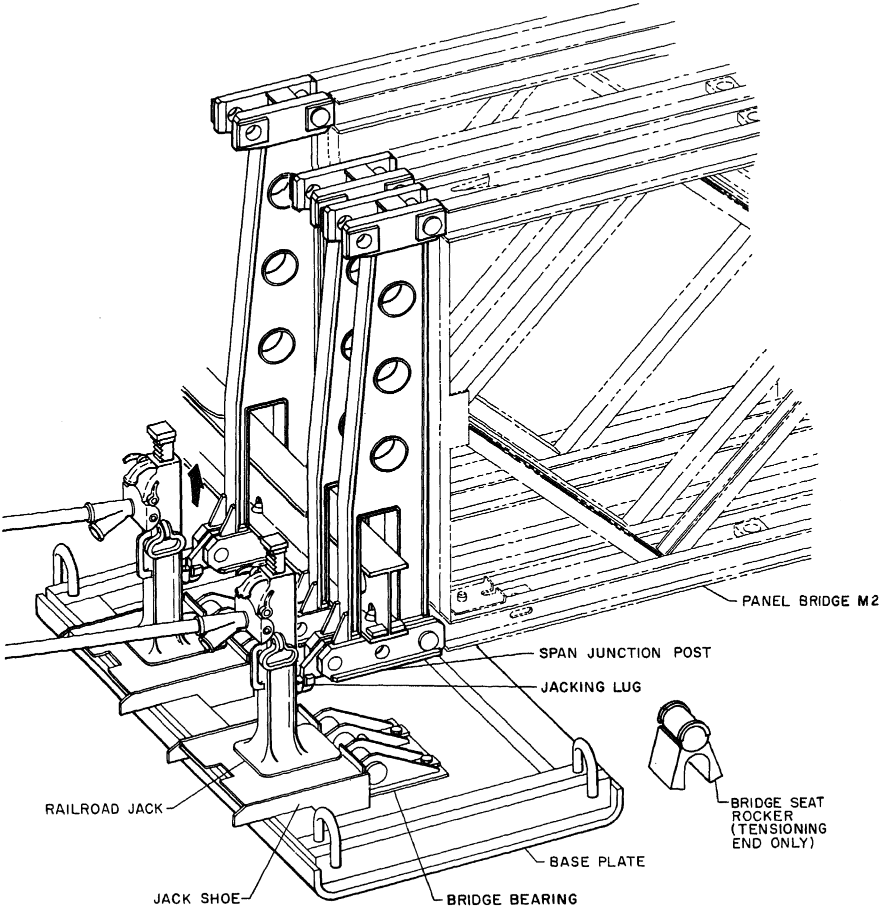


Figure 15–46. Jacking up end of M2 panel bridge to install cable connection beam.

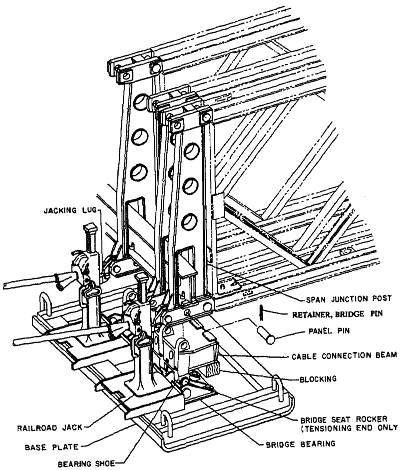


Figure 15–47. Positioning cable connection beam under span junction posts.

through the center hole of the cable connection beam; if four cables are used, two on each side, no cable is threaded through the center hole. Continue the threading operation until the cable button stamped with the number corresponding to the span length in feet has passed through the cable connection beam.

(2) Place two half cable retainers between the button and the cable connection beam bearing surface (fig 15–23) to prevent the button from being pulled through the cable connection beam during cable tensioning.

(3) At the tensioning end of the bridge, remove cable and cylinder nuts from pull rod and thread pull rod into the rod-to-cable coupling. Continue turning the pull rod until it bottoms in the rod-to-cable coupling. Turn pull rod back one half turn or more to aline the hole through the pull rod and rod-to-cable coupling. Insert a ½-inch diameter bolt (fig 15–49) through the rod-to-cable coupling and pull rod. Install a hex nut on the end of the bolt. Thread the coupling onto the stud end of cable until it bottoms. Insert a ½-inch diameter setscrew.

(4) Feed pull rod through the proper hole in the cable connection beam and retain with the cable nut (fig 15–50). The cable nut is then advanced so that the pull rod extends beyond the cable connection beam a minimum of 21 inches. This may be done by: (a) threading the eyebolt on the 12-foot pull rod chain into the pull rod and pulling, advancing the cable nut as the pull rod advances, (b) advancing the pull rod using hemp rope tied to the cable at or near the rod-to-cable coupling, or (c) advancing the cable nut using a chord bolt wrench.

(5) Position cable below vertical posts and remove all rope lashings from the cable.

Caution. **The cable must be guided into the correct slot of the vertical post saddle by bridge personnel while the cables are being tensioned.**

(6) Repeat steps (1) through (5) to install all cables on the bridge. After cables are installed on both sides of the bridge, secure each cable retainer to the vertical post saddle with four ½-inch diameter bolts and hex nuts.

15–27. Installation of Cable Reinforcement Set on an Existing Panel Bridge, M2

a. Placement of Materiel.

(1) The contents of the trucks carrying all assemblies and component parts are placed on each side of the bridge as close to the area of installation as possible.

(2) The cable reels are removed from the trucks on the near shore and installed on cable reel supports (para 15–26*a*) on each side of the roadway, close to the bridge.

b. Installation of Cable Supporting Structures. Install the post connection fixture, post assembly, brace connection fixtures, and longitudinal and transverse braces in accordance with paragraph 15–26*b* and as follows:

(1) Using rope, lower post connection fixture over the side. Pull up into position using ropes placed through the two openings between the three panels. Note that the bearing plate on top of the post connection fixture must be placed under the center panel.

(2) Remove cable retainer from vertical post by removing four ½-inch diameter bolts and hex nuts. Install the vertical post using a rope over the outside of the bridge. Attach two ropes to the top of the vertical post and pull it into position with the ropes through the two openings between the three panels. Note that the fixtures on the vertical post for the transverse braces must be on the inside.

(3) Attach the brace connection fixtures in a similar manner. Note that the bolts on the brace connection fixture not using the slotted holes in the bridge panel should not be tightened yet, in order to allow for lateral movement when fitting the longitudinal brace.

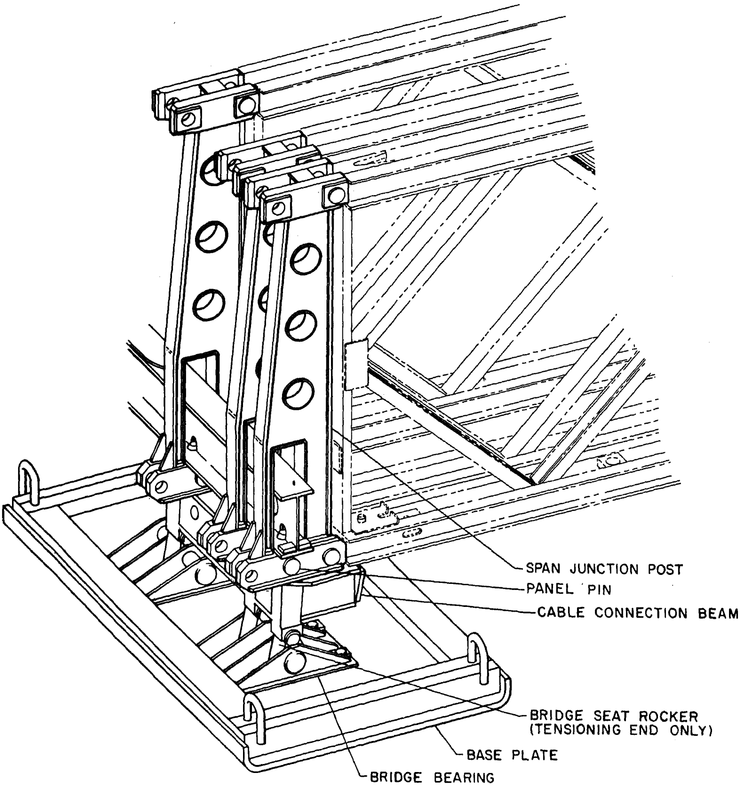
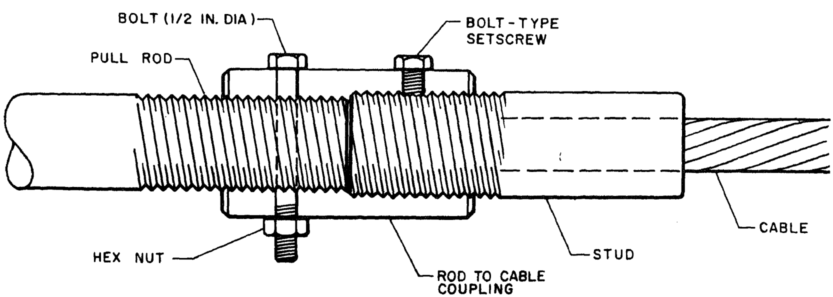


Figure 15–48. M2 Bailey bridge jacked down on bridge bearing plate.



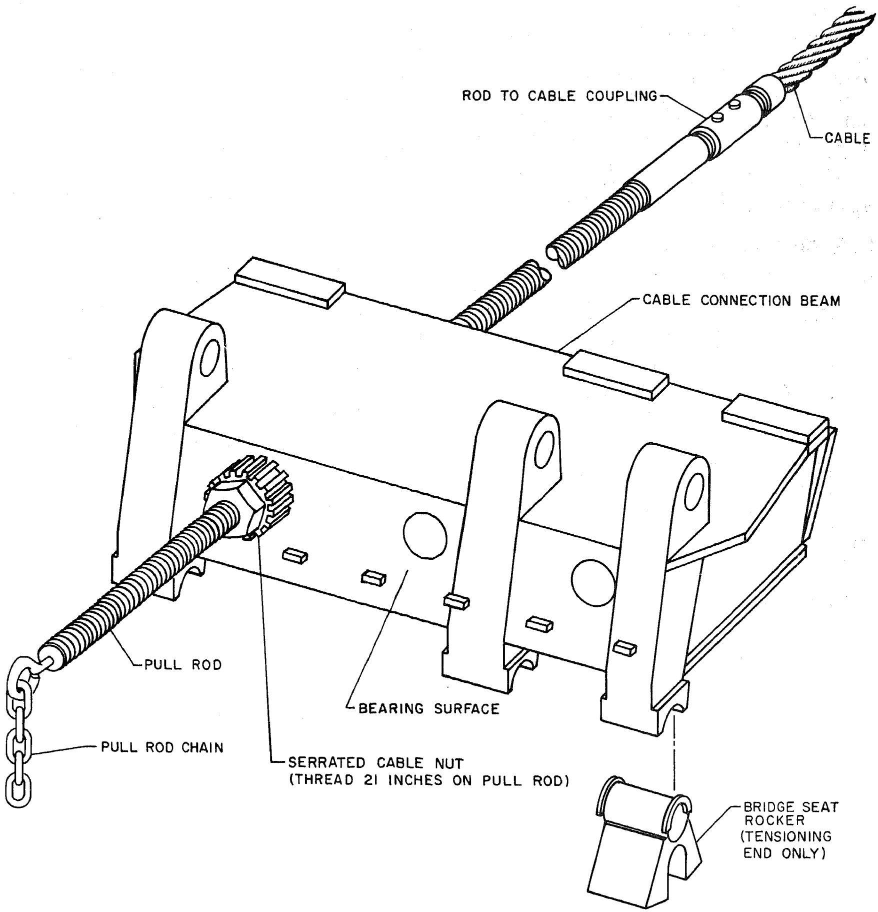


Figure 15–50. Cable nut retaining pull rod in cable connection beam.

(4) Attach the longitudinal and transverse braces using a boatswain's chair.

***Caution.* All personnel who are lowered over the side of the bridge in a boatswain's chair must also wear a safety belt connected to a lashing which, in turn, is secured to the side of the bridge.**

c. Installation of Span Junction Posts and Cable Connection Beams.

(1) Jack up the end of the bridge (para 15–26f) enough to place cribbing under the lower panel chords near the end posts to temporarily support the bridge. Remove jacks from end of bridge.

Note. Ignore any reference made to rocking rollers since these items have been previously removed from under the bridge.

(2) Remove standard end posts from the bridge and install span junction posts in accordance with paragraph 15–26*d*.

(3) Install cable connection beams in accordance with paragraph 15–26*g*.

d. Installation of Cable Assemblies.

(1) Refer to steps (1), (2), and (3) of paragraph 15–26*c* for preliminary procedure to prepare cables for installation on the bridge.

(2) Carry the cable across the bridge and install button end of cable through cable connection beam on far shore (steps (1) and (2), para 15–26*h*).

(3) Follow steps (3) through (6) of paragraph 15–26*h* to complete installation of cables.

15–28. Cable Tensioning

Before tensioning the cables, set up a level reference so the deflection of a point on the bridge at midspan, relative to a point at the support, can be measured. The purpose of measuring deflections is to provide a check during cable tensioning. Tension all cables simultaneously. Use the following procedure to tension each cable.

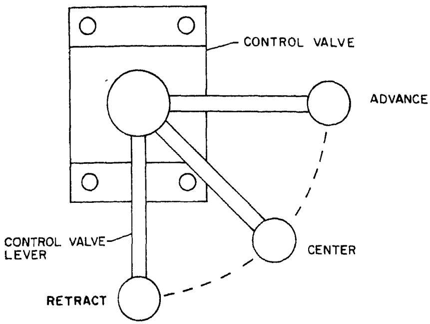


Figure 15–51. Hydraulic power unit control valve positions.

Note. One 10-kw or two 5 kw, 60-cycle ac generators are required for operation of the hydraulic power unit.

a. Install an adapter and a double-acting hydraulic cylinder on each pull rod assembly (fig 15–32). Connect hydraulic hoses to the cylinders and the hydraulic power unit. Install and tighten cylinder nut on each pull rod to retain adapter and cylinder of cable tensioning assembly (fig 15–25).

b. The hydraulic power unit is operated as follows:

(1) Loosen filler plug to vent the reservoir.

(2) Place the control valve lever in the advance position (fig 15–51).

(3) Turn switch to "RUN" position.

(4) Turn switch to "OFF" position when any cylinder has reached full stroke. The "JOG" position on the switch may be used to run the power unit in short bursts.

(5) Pressure may be slowly released by moving the control valve lever toward the center position.

(6) The dial indicating cable tension gage

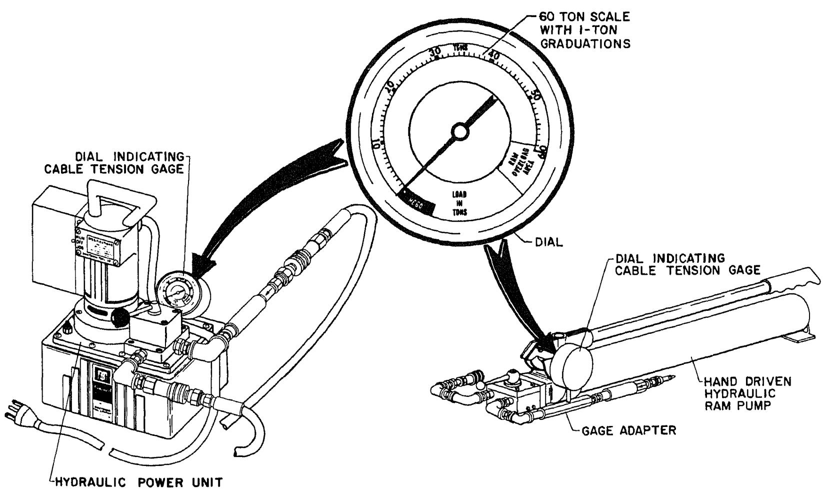


Figure 15–52. Dial indicating cable tension gage.

(fig 15–52) is located on the hydraulic power unit of the cable tensioning assembly and the hand-driven hydraulic ram pump. The gage is $3\frac{1}{2}$ inches in diameter and has 1-ton graduations on the dial throughout a 60-ton scale. Cable tensions for the various bridge spans are given in table 15–1.

Note. Loads should be read while tensioning cables. Readings during detensioning are inaccurate due to gage lag.

(7) The retract position is used to return the cylinders to normal operating position, after the cable nuts have been tightened during tensioning procedures.

c. Operate the hydraulic power unit of the cable tensioning assembly to cause one complete stroke of the cylinder at a time to tension the cables. Cable tensioning is accomplished in increments of cylinder strokes.

d. As the cylinder advances, tighten the cable nut by hand against the bearing surface of the cable connection beam. At the end of each cylinder stroke, release pressure, retract cylinder, and hand tighten cylinder nut back to retracted cylinder.

Note. If cable nut cannot be hand tightened because thread on pull rod is damaged or burred, use a Bailey structural wrench, as shown in figure 15–53, to pry cable nut free of damaged area. Hand tightening of cable nut can then be continued. Cylinder nut can also be turned through damaged or burred threads using a chord bolt wrench.

e. Repeat steps *c* and *d* until the load, as indicated on the gage of the cable tensioning assembly (fig 15–54), is equal to 2 tons more than the value listed in table 15–1 (fig 15–55). Then slowly release pressure in the hydraulic cylinder by slightly opening the valve on the hydraulic power unit until the gage indicates a tension value 4 tons less than that listed in table 15–1. Repressurize to the appropriate value in table 15–1. This must be done with the cylinders near midstroke.

Note. This procedure eliminates the friction between the cable and the vertical post.

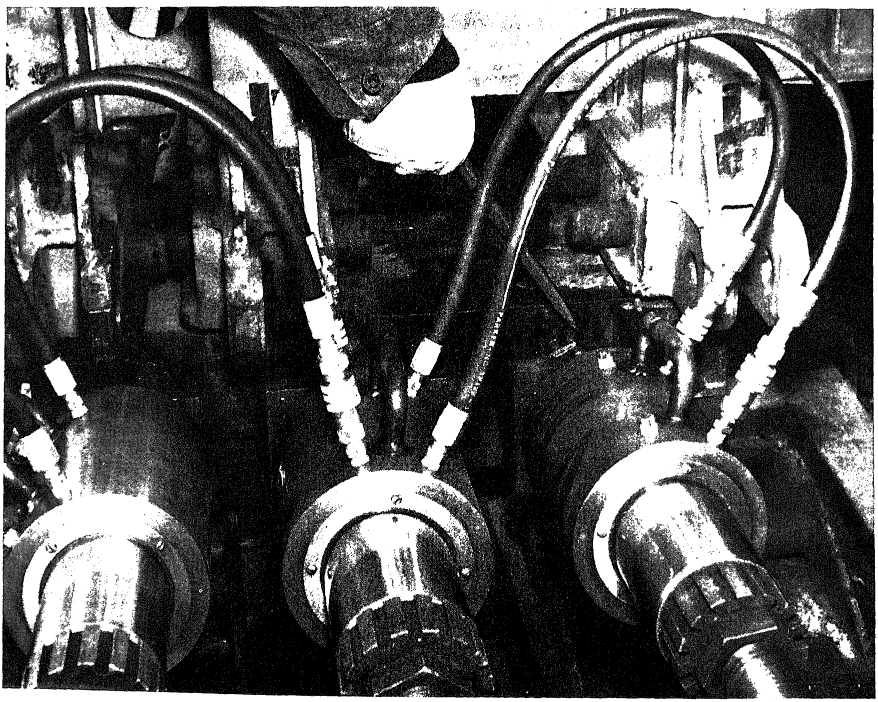


Figure 15–53. Using Bailey structural wrench to pry cable nut free of damaged area.

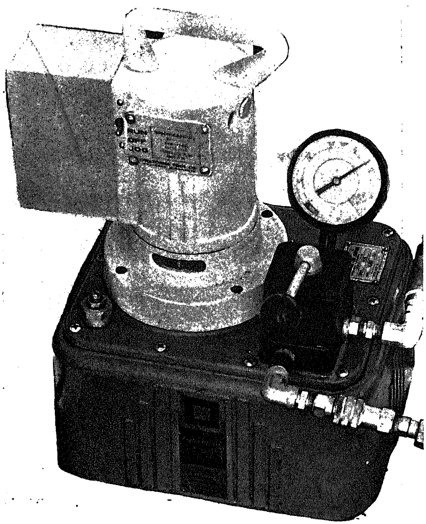


Figure 15–54. Cable tension indicated on cable tension indicating gage.

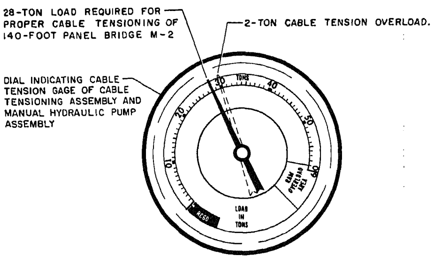


Figure 15–55. Typical example of load adjustment to eliminate cable friction as indicated on dial indicating cable tension gage.

f. Tighten the cable nut against the bearing surface of the cable connection beam.

g. Release all pressure in the cable tensioning assembly by opening the valve on the power unit. Then hand tighten the cylinder nut against the cylinder.

Note. Cylinders must be fully retracted before disconnecting hydraulic power unit.

h. Measure the deflection of the bridge at midspan, relative to the end of the bridge. Compare the measured value obtained to the values shown in table 15–1. If the deflection measurement is less than the values listed in table 15–1, refer to paragraph 15–36 for troubleshooting procedures to correct conditions. As part of regular maintenance, cable tension should be checked using the manual hydraulic pump assembly by pressurizing the cylinders just enough to free the cable nuts, and comparing the gage reading with the cable tension value in table 15–1.

15–29. Dismantling

a. General. The sequence of dismantling of the cable reinforcement set described in this paragraph must be closely followed in order to prevent damage to equipment or possible injury to personnel.

b. Relieving Cable Tension. Unload tension on all cables simultaneously using the following procedure:

(1) Move cylinder nuts away from cylinders to ¼ inch less than full cylinder stroke. By pumping, increase the load on each cable until the cable nut turns freely.

(2) Keep cable nut free of the cable connection beam bearing surface while carefully opening the valve on the power unit, permitting the cylinder to slowly collapse.

(3) Tighten the cable nut against the bearing surface when the cylinder is almost completely collapsed. The cylinder should not be completely collapsed because tension in the cable prevents hand loosening of the cylinder nut.

(4) Repeat steps (1) through (3) until tension in the cables is relieved and cables are free of vertical post saddles.

(5) With cable nut against bearing surface of cable connection beam, remove cylinder nut, cylinder, and adapter from pull rod.

c. Retrieving Cable. The following procedure for cable removal shall be used for all cables installed on the M2 panel bridge.

(1) Reinstall lashing ropes 20 feet apart, along the entire length of the cables. Make certain that cables are fully supported by lashings before continuing with removal operations.

(2) Remove cable retainer from each vertical post saddle by removing four bolts and hex nuts.

(3) On the near-shore tensioning end of the bridge, continue retrieval as follows:

(*a*) Unscrew cable nut from pull rod.

(*b*) Pull pull rod out of cable connection beam.

(*c*) Remove bolt and hex nut which retain the pull rod in the rod-to-cable coupling.

(*d*) Unthread pull rod from rod-to-cable coupling.

(*e*) Reinstall cable and cylinder nuts on threads of pull rod.

(4) On the far shore, pull the cable from the dead-end cable connection beam far enough to remove half cable retainers. Then pull the cable back through the dead-end cable connection beam.

(5) Lift cable up and over panels of the bridge. Carry cable to the cable reel. Wind cable on the cable reel, removing lashing ropes as cable wraps on the reel.

***Caution.* During winding of cable on cable reel, be careful to prevent cable buttons from snagging on structure, and cable from wearing against anything which could fray or break the wire.**

d. Cable Connection Beams and Span Junction Posts. Remove safety pins from ends of panel pins (fig 15–47). Place safety cribbing under the lower panel chords. Install jacking lugs and railroad jacks, and jack up end of bridge enough to unload panel pins connecting span junction posts to the cable connection beams. Pull the panel pins from cable connection beams. Continue jacking up end of bridge until cable connection beam is clear of span junction posts. Install rocking rollers as when dismantling normal bailey bridge (chap 23). Jack bridge down onto rocking rollers. Remove jacks, jack shoes, jacking lugs, span junction posts, and cable connection beams.

e. Posts and Bracing. Removal of braces, post assemblies, and connection fixtures is the reverse of installation procedures outlined in paragraph 15–26*b*. After removal of post assemblies from bridge, reinstall cable retainer on vertical post saddle with four ½-inch diameter bolts and hex nuts.

f. Conclusion. Continue removal of the bridge as outlined in chapter 23.

Section IV. OPERATION UNDER UNUSUAL CONDITIONS

15–30. General Instructions

The cable reinforcement set can be installed and used in all extremes of temperature without modification to existing components. Cable tensions in table 15–1 are higher than required under normal conditions, to compensate for extremes of temperature.

15–31. Operation in Dusty, Sandy, Tropical, or Salty Areas

Lubricate cable, bridge seat rockers, threaded surfaces, and slots in vertical post saddles in accordance with paragraph 15–33. Paint surfaces of parts which are subject to rust and corrosion, in accordance with TM 9–213, if surfaces indicate absence of paint or excessive weathering. Do not paint cable.

Section V. OPERATOR'S AND ORGANIZATIONAL MAINTENANCE

15–32. Repair Parts, Tools, and Equipment

Tools and equipment normally issued to the panel bridge company and those issued with the cable reinforcement set are adequate for maintaining this set. All maintenance operations will be performed by the using organization. Basic issue tools and supplies issued with or authorized for the cable reinforcement set are listed in the basic issue items list, appendix B. There are no special tools required to perform operator's and organizational maintenance on the cable reinforcement set. Organizational maintenance repair parts are listed and illustrated in appendix C.

15–33. Lubrication

a. Lubrication Chart. This paragraph contains a lubrication chart (fig 15–56) plus some special lubrication instructions not specifically covered in the chart.

b. Care of Lubricants. Keep all lubricants in closed containers and store in a clean, dry place away from external heat. Allow no dust, dirt, water, or other foreign material of any kind to mix with the lubricants. Keep all lubrication equipment clean and ready to use.

c. Points of Lubrication. Service the lubrication points at proper intervals as illustrated in figure 15–56.

d. Cleaning. Keep all external parts not requiring lubrication clean of lubricants. Before lubricating the equipment, wipe all lubrication points free of dirt and grease. Clean all lubrication points after lubricating to prevent the accumulation of foreign matter.

15–34. Preventive Maintenance Checks and Services

To insure that the cable reinforcement set is

LUBRICATION CHART

CABLE REINFORCEMENT SET

Reference: C9100-1L

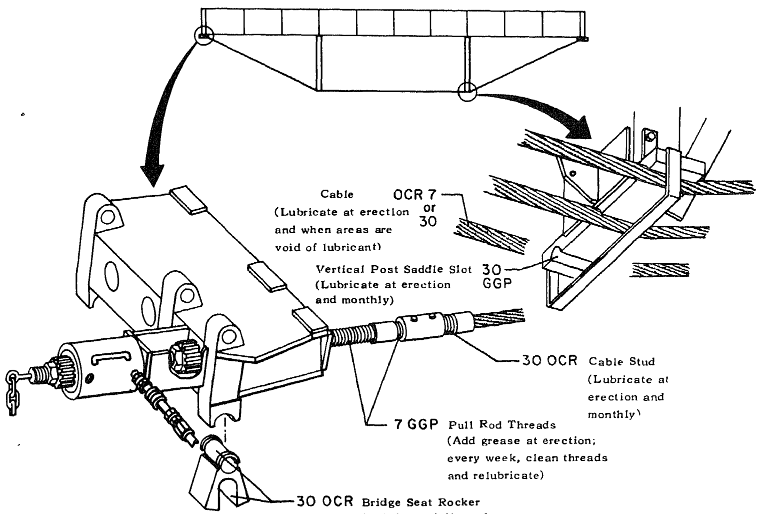
Intervals are based on normal days of operation. Adjust to compensate for abnormal operations and severe conditions. During inactive periods, sufficient lubrication must be performed for adequate preservation.

Clean parts with SOLVENT, dry-cleaning, or with OIL, fuel, Diesel. Dry before lubricating.

Relubricate after washing.

— KEY —

LUBRICANTS	CAPACITY	ALL TEMPERATURES	INTERVALS
OCR – LUBRICATING OIL		OCR	Intervals are based on normal days of operation.
GGP – GREASE, General Purpose		GGP	



LUBRICANTS. The following is a list of lubricants with the Military Symbols and applicable numbers.
OCR-VV-L-751 GGP-MIL-G-23549

Figure 15-56. Lubrication chart.

ready for operation at all times, it must be inspected systematically so that defects may be discovered and corrected before they result in serious damage or failure. The necessary preventive maintenance checks and services to be performed are listed and described in table 15–3. The item numbers indicate the sequence of minimum inspection requirements. Defects discovered during operation of the unit will be noted for future correction, to be made as soon as operation has stopped. Stop operation immediately if a deficiency is noted during operation which would damage the equipment if operation were continued. Every organization equipped with the cable reinforcement set must train its personnel in performing effective maintenance on it.

Table 15–3. Cable Reinforcement Set—Preventive Maintenance Checks and Services

Item No.	Interval: Operator-crew, Daily B	D	A	W	Organizational M	Q	Item to be inspected	Procedure	Reference
							B–Before operation, D–During operation	A–After operation, W–Weekly	M–Monthly, Q–Quarterly
							LUBRICATE IN ACCORDANCE WITH LUBRICATION CHART		
1	X			X	X		Cable	Inspect for kinks, broken wires, and fraying around cable buttons. Check cable at vertical post saddle for excessive wear.	
2	X			X			Rod-to-cable coupling	Check for security to cable stud. Retighten set screw.	
3	X			X	X		Pull rods	Inspect threads for cleanliness, burrs, and binding of cable and cylinder nuts, which may indicate stripped threads.	
4				X			Half cable retainer	Check for security between bearing surface of cable connection beam and cable button.	
5	X						Saddle on vertical post base.	Inspect for sharp edges which could cause excessive wear of cable. Dress burred surfaces.	
6	X			X			Hydraulic cylinder assemblies.	Inspect fittings, reservoir, hose assemblies, and cylinders for leakage of oil.	See para 15–35.
7				X	X		Bolts and nuts	Check security of all parts. Bolts should be turned one quarter beyond handtightness.	
8	X			X			Cable tension	Pressurize cylinder until cable nuts are free from connection beam bearing surface. With no vehicles on bridge, gage should read correct value from table 15–1, allowing for temperature variation. Either hand pump or hydraulic power unit can be used.	
9	X	X	X	X	X		Bridge seat rockers	Visually inspect for proper emplacement, breakage, and wear.	

15–35. Maintenance Procedures

The following maintenance procedures will be performed by the using organization.

a. Servicing the Cable Tensioning and Manual Hydraulic Pump Assemblies. Servicing of the cable tensioning assembly and the manual hydraulic pump assembly consists of checking the level of the hydraulic oil in the reservoir of the pumping unit and filling or draining this component; and replacing the gage, quick disconnect couplings, or hose assemblies when inspection reveals need for parts replacement.

Note. The following standard procedures should always be used when disassembling a hydraulic component:

(1) Make certain all pressure has been relieved before opening any part of a hydraulic component.

(2) Provide a container to catch any draining fluid.

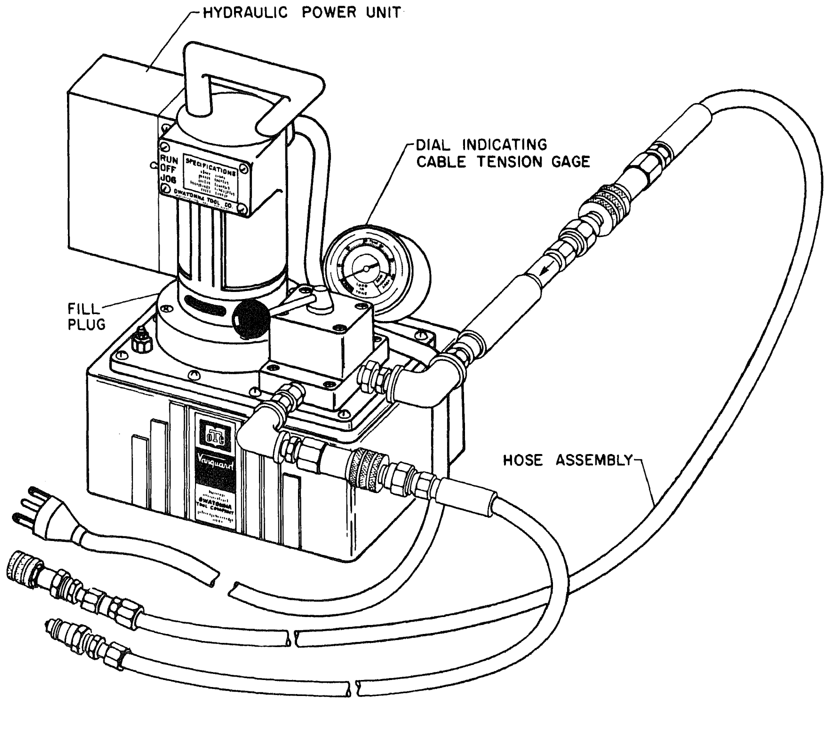
(3) Cover any exposed openings to prevent foreign matter from entering the hydraulic system.

(4) Apply a small amount of pipe dope to all threaded connections to assure a tight connection.

***Caution.* Do not permit open flames in immediate area because hydraulic fluid is flammable.**

b. Servicing the Pump Reservoirs. Service the pumping reservoirs as illustrated in figures 15–57 and 15–58.

c. Replacing Parts. Replace the following parts of the cable tensioning assembly and manual hydraulic pump assembly, as illustrated and de-

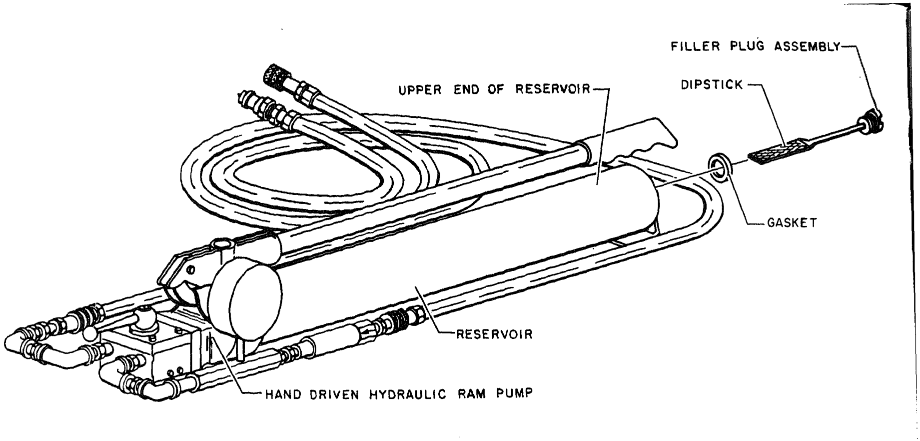


STEP 1.
REMOVE FILLER PLUG FROM TOP OF PUMPING UNIT RESERVOIR. OIL SHOULD BE 3 INCHES BELOW TOP SURFACE OF RESERVOIR.

STEP 2.
ADD OR DRAIN HYDRAULIC OIL CONFORMING TO SPECIFICATION MIL-L-10295, LUBRICATION OIL, OES 10. DO NOT OVERFILL.

STEP 3.
REINSTALL FILLER PLUG IN TOP OF PUMPING UNIT RESERVOIR.

Figure 15–57. Servicing hydraulic power unit reservoir.



STEP 1.
PLACE PUMPING UNIT IN VERTICAL POSITION WITH HOSE END DOWN.

STEP 2.
REMOVE FILLER PLUG AND GASKET FROM UPPER END OF PUMPING UNIT RESERVOIR. OIL SHOULD BE VISIBLE ON FLAT PART OF DIPSTICK.

STEP 3.
ADD OR DRAIN HYDRAULIC OIL CONFORMING TO SPECIFICATION MIL-H-10295, LUBRICATION OIL, OES 10. DO NOT OVERFILL.

STEP 4.
REINSTALL GASKET AND FILLER PLUG ASSEMBLY IN END OF PUMPING UNIT RESERVOIR: THEN RETURN PUMPING UNIT TO HORIZONTAL POSITION.

Figure 15–58. Servicing hand-driven hydraulic ram pump reservoir.

scribed in figures 15–59 and 15–60 respectively, when inspection reveals the need for their replacement.

(1) Dial indicating cable tension gage.

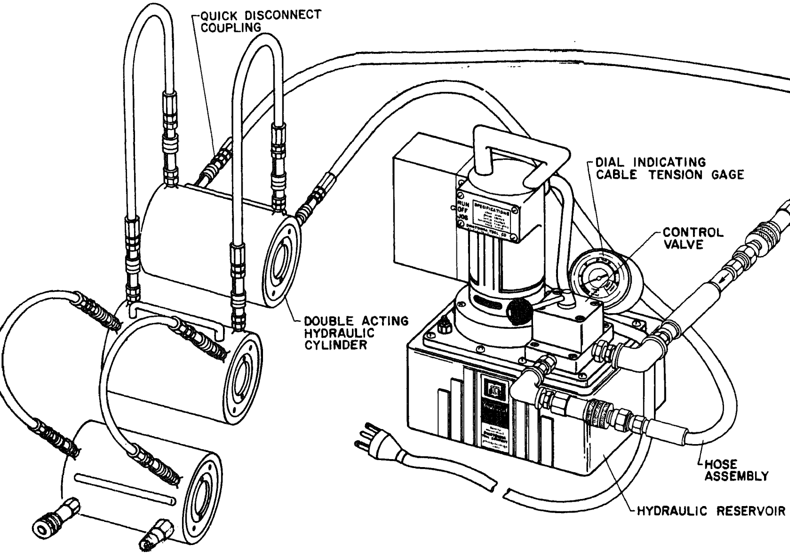
(2) Hose assemblies and quick disconnect couplings.

(3) Gage adapter (hand pump only).

(4) Cylinders (cable tensioning assembly only).

15–36. Troubleshooting

This paragraph provides information useful in diagnosing and correcting unsatisfactory operation or failure of the cable reinforcement set and its components. Malfunctions which may occur are listed in table 15–4. Each malfunction is followed by a list of probable causes of the trouble and the corrective action recommended to remedy it.



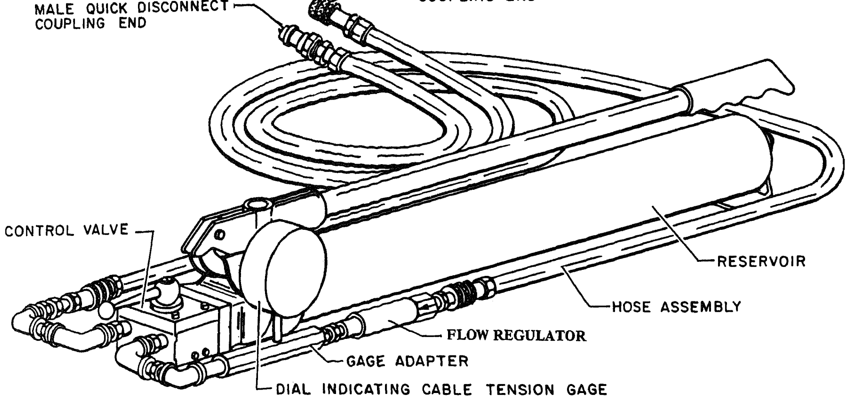
STEP A.
. UNSCREW GAGE FROM PORT.
2. INSTALL TEMPORARY PLUG TO PREVENT ENTRY OF FOREIGN MATTER IN HYDRAULIC FLUID.
3. REMOVE PLUG AND INSTALL NEW GAGE IN PORT.

STEP B.
1. DISCONNECT QUICK DISCONNECT COUPLINGS FROM CYLINDER.
2. THE FOLLOWING PROCEDURE IS USED TO REPLACE HOSES AND FITTINGS:
   (a) PUMP HOSES.
      (1) UNSCREW MALE QUICK DISCONNECT COUPLING HALF OR FLOW REGULATOR AND UNSCREW HOSE FROM VALVE FITTING.
      (2) UNSCREW PIPE FITTINGS FROM VALVE.
      (3) UNSCREW FLOW REGULATOR FROM PIPE NIPPLE.
      (4) UNSCREW PIPE NIPPLE FROM FEMALE QUICK DISCONNECT COUPLING.
      (5) INSTALL TEMPORARY PLUGS IN ALL PARTS.
      (6) DISCARD DEFECTIVE PART AND ASSEMBLE IN REVERSE ORDER INSURING THAT FLOW REGULATOR IS INSTALLED PROPERLY.
   (b) CYLINDER HOSE.
      (1) UNSCREW QUICK DISCONNECT COUPLING HALF FROM END OF HOSE AND UNSCREW HOSE FROM CYLINDER.
      (2) INSTALL TEMPORARY PLUGS.
      (3) INSTALL NEW PARTS IN REVERSE ORDER.
3. RECONNECT QUICK DISCONNECT COUPLINGS TO CYLINDER.

STEP C.
1. UNSCREW QUICK DISCONNECT COUPLING HALF FROM PIPE NIPPLE.
2. UNSCREW PIPE NIPPLE FROM CYLINDER.
3. INSTALL TEMPORARY PLUG IN CYLINDER.
4. INSTALL NEW PARTS IN REVERSE ORDER.

NOTE: FOLLOWING ANY REPLACEMENT PROCEDURES, REFER TO FIGURE 15-57 FOR CHECKING FLUID LEVEL OF HYDRAULIC SYSTEM. ADD OR REMOVE HYDRAULIC FLUID TO MAINTAIN PROPER FLUID LEVEL FOR EFFICIENT OPERATION OF CABLE TENSIONING ASSEMBLY.

Figure 15–59. Replacement of gage, hose assembly, and/or quick disconnect coupling of cable tensioning assembly.



STEP A.

1. UNSCREW GAGE FROM PORT OF GAGE ADAPTER.
2. INSTALL TEMPORARY PLUG TO PREVENT ENTRY OF FOREIGN MATTER IN HYDRAULIC FLUID.
3. REMOVE PLUG AND INSTALL NEW GAGE IN PORT OF GAGE ADAPTER.

STEP B.

1. UNSCREW MALE QUICK DISCONNECT COUPLING FROM ONE HOSE AND UNSCREW HOSE FROM BUSHING AT VALVE. DISCONNECT FLOW REGULATOR FROM OTHER HOSE AND UNSCREW HOSE FROM BUSHING AT GAGE ADAPTER.
2. UNSCREW BUSHING FROM VALVE AND GAGE ADAPTER.
3. UNSCREW GAGE ADAPTER FROM VALVE.
4. UNSCREW FLOW REGULATOR FROM PIPE NIPPLE.
5. UNSCREW PIPE NIPPLE FROM FEMALE QUICK DISCONNECT COUPLING.
6. INSTALL TEMPORARY PLUGS IN ALL PARTS.
7. DISCARD DEFECTIVE PARTS AND REASSEMBLE NEW PARTS IN REVERSE ORDER OF DISASSEMBLY. MAKE CERTAIN THAT FLOW REGULATOR IS INSTALLED PROPERLY.

NOTE: FOLLOWING ANY REPLACEMENT PROCEDURES, REFER TO FIGURE 15-58 FOR CHECKING FLUID LEVEL OF HYDRAULIC SYSTEM. ADD OR REMOVE HYDRAULIC FLUID TO MAINTAIN PROPER FLUID LEVEL FOR EFFICIENT OPERATION OF HAND DRIVEN HYDRAULIC RAM PUMP.

Figure 15–60. Replacement of gage, hose assembly, quick disconnect coupling, and/or gage adapter of manual hydraulic pump assembly.

Table 15-4. Troubleshooting

Malfunction	Probable cause	Corrective action
1. Failure to attain deflection within limits specified (table 15-1).	a. Leak in cable tensioning assembly causing low or no pressure in hydraulic cylinders.	a. Inspect for leakage in hydraulic power unit, hose assembly or fittings. Service hydraulic cylinder assembly (para 15-35) or replace components or assembly with new parts.
	b. Defective dial indicating cable tension gage.	b. If inspection indicates defective gage, replace with new part (para 15-35).
	c. Collapse of vertical post	c. Inspect for broken welds, loose bracing, or connection fixtures. Repair welds and retighten all loose parts.
	d. Stripped threads on pull rod	d. Replace pull rod assembly.
	e. Collapse of cable	e. Inspect for proper position of half cable retainers or broken wires. Reposition and secure half cable retainers. Replace cable assembly if broken wires are found. Retension cable (para 15-28.) in accordance with table 15-1.
2. Failure to maintain deflection within limits specified (table 15-1).	a. Yielding of buttons or stud or cable assembly.	a. Replace cable assembly.
	b. Inelastic deformation of cable	b. Re-tension cable (para 15-28.) in accordance with table 15-1.
	c. Stripping of threads on pull rod	c. Replace pull rod.

15-37. Field Expedient Repairs

Malfunction may occur while the cable reinforcement set is being operated in the field where supplies and repair parts are not available and normal corrective action cannot be performed. When this occurs, the following expedient remedies may be used:

Malfunction	*Expedient remedy*
Failure of one cable tensioning assembly.	One cable tensioning assembly may be used to tension the cables as follows: Tension cables on one side to 5 tons, then tension the other side to 5 tons. Continue alternating at 5-ton increments to the tension indicated in table 15-1, following steps of paragraph 15-28.
Defective dial indicating cable tension gage.	Tension cable and measure upward deflection of the truss continuously. The vertical deflections to produce required table tension are shown in table 15-1.

Section VI. SHIPMENT AND LIMITED STORAGE

15-38. Preparation of Cable Reinforcement Set for Shipment

This paragraph gives detailed instructions for the preparation of the unit for domestic shipment.

a. Inspection. Inspect the entire unit for any unusual conditions such as damage, rusting, and pilferage. Perform the preventive maintenance services as outlined in paragraph 15-34.

b. Cleaning and Drying. Remove all contamination from the unit by an approved method. Approved methods of cleaning and drying, types of preservatives, and methods of application are described in TM 38-230-1.

c. Painting. Repaint all surfaces where the paint has been removed or damaged. DO NOT paint the cables.

d. Depreservtion Guide DA Form 2258 (Depreservation Guide for Vehicles and Equipment).

(1) Complete properly annotated depreservation guide concurrently with preservation for each item of mechanical equipment, with any peculiar requirements outlined in the blank spaces on the form. Place the completed depreservation guide in a waterproof envelope marked "Depreservation Guide, and fasten it in a conspicuous location.

(2) Before placing equipment in operation, or to the extent necessary for inspection, perform depreservation of the item as outlined in the depreservation guide.

e. Exterior Surfaces. Coat exposed machined surfaces with preservative (P–6) conforming to specification MIL–C–11796, class 3. If preservative is not available, GGP–GREASE, General Purpose, may be used.

15–39. Loading the Equipment for Shipment

a. Loading. Use a lifting device of suitable capacity to lift heavy components. The cable reinforcement set may be transported in three M51 trucks. One truck transports cables, reels, and supports, another transports the span junction posts, and the third truck transports the remaining parts of the cable reinforcement set (fig 15–6, 15–7, and 15–8).

***Caution.* Attach a guide rope when lifting the equipment to avoid swinging and damaging the cable reinforcement set.**

b. Blocking. Securely block and lash the cable reinforcement set in M51 trucks. The cable tensioning assembly is contained in its own box with protective wrapping. Also the pull rods can be stored in cardboard tubes to protect the threads from dirt or other foreign matter. This set may also be stored in a shelter or motor pool. If stored in the open, make certain components are placed on cribbing to reduce rust and corrosion.

15–40. Limited Storage

Procedures for preserving and maintaining equipment for limited storage are the same as those for preparing the set for shipment, as outlined in paragraph 15–389 Limited storage is defined as storage not to exceed 6 months. Refer to AR 743–505. Every 30 days, the cable reinforcement set should be inspected and represerved as necessary.

Section VII. DEMOLITION OF SET TO PREVENT ENEMY USE

15–41. Responsibility

When capture or abandonment of the cable reinforcement set is imminent, the responsible unit commander must make the decision either to destroy the equipment or to make it inoperative. Based on this decision, orders are issued which cover the desired extent of destruction. Whatever method of demolition is used, it is essential to destroy the same vital parts of all cable reinforcement sets and all corresponding repair parts.

15–42. Demolition To Make the Cable Reinforcement Set Inoperative

a. Demolition by Mechanical Means. Use sledge hammers, crowbars, picks, axes, or any other heavy tool which may be available to destroy the following bridge components:

(1) Post assemblies, fixtures, and braces.

(2) Cable connection beams and span junction posts.

(3) Cable assemblies.

(4) Cable tensioning or manual hydraulic pump assemblies.

b. Demolition by Explosives or Weapons Fire.

(1) *Explosives.* Place as many charges as the situation permits. Detonate charges simultaneously with detonating cord and suitable detonator. At least one ½-pound charge should be placed on each cable and each cable connection beam assembly.

(2) *Weapons Fire.* Fire on the cable connection beams and vertical posts with the heaviest suitable weapons available.

15–43. Training

All operators should receive thorough training in the destruction of the cable reinforcement set. Simulated destruction, using all methods listed above, should be included in the operator training program. It must be emphasized in training that demolition preparations are usually necessitated by critical situations when time available for destruction is limited. For this reason, it is necessary that operators be thoroughly familiar with all methods of destruction of equipment and be able to carry out demolition instructions without reference to this or any other manual.

CHAPTER 16

BRIDGES ON PIERS

Section I. BROKEN-SPAN BRIDGES

16–1. General

Long simple spans become increasingly uneconomical because of excessive dead weight and reduced class. Generally, intermediate piers should be used to avoid assembly of class 50 continuous spans longer than 150 feet or class 75 continuous spans longer than 120 feet. Bridges supported by piers may be either broken (at each pier) into separate spans or continuous for their entire length. For efficient assembly, the time required to assemble one span and prepare it for launching should be as nearly equal as possible to the time required to assemble and place one pier.

16–2. Types of Assembly

Broken-span bridges are multispan structures with the top chord broken and the bottom chord either broken or pinned at the piers. The two adjacent spans act independently under load. One advantage of broken-span over continuous-span

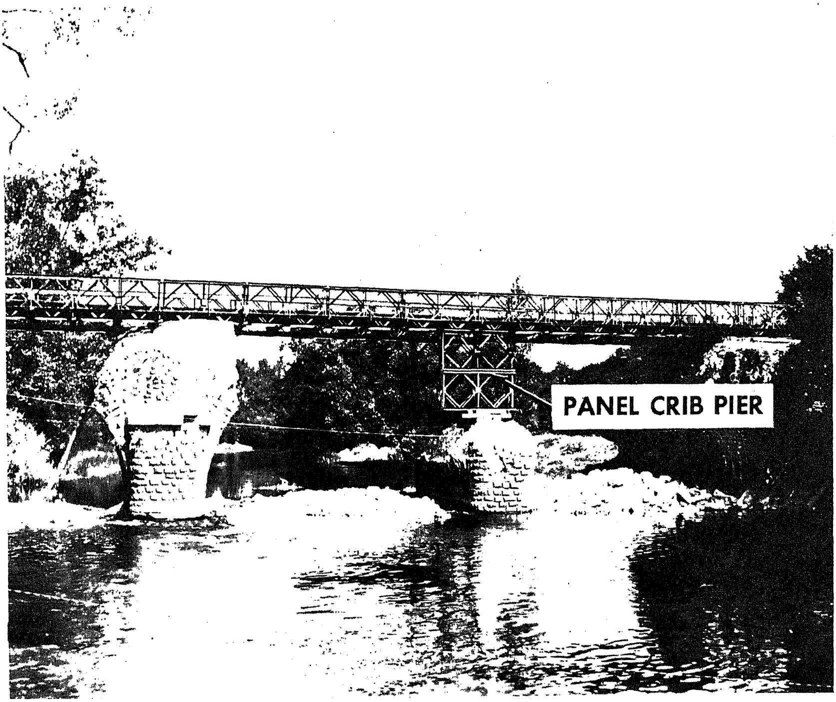


Figure 16–1. Continuous panel bridge supported on damaged masonry pier and a panel crib pier.

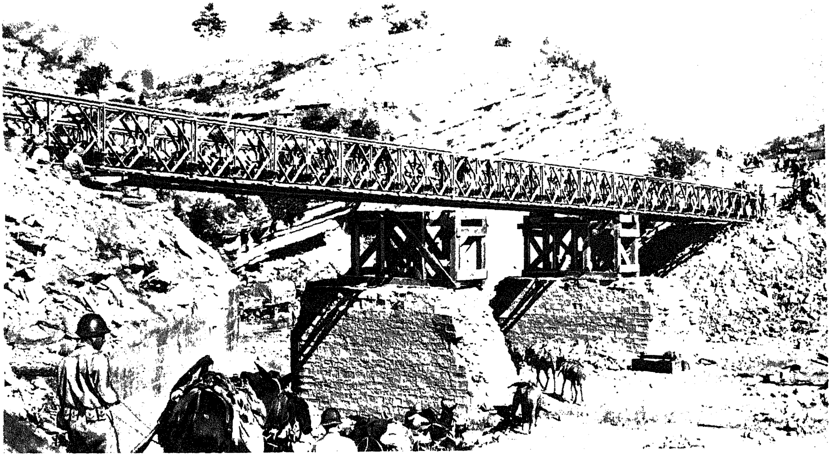


Figure 16–2. A 170-foot DS continuous panel bridge supported on timber piers. Near end of bridge is jacked up preparatory to inserting expedient bearings on near pier.

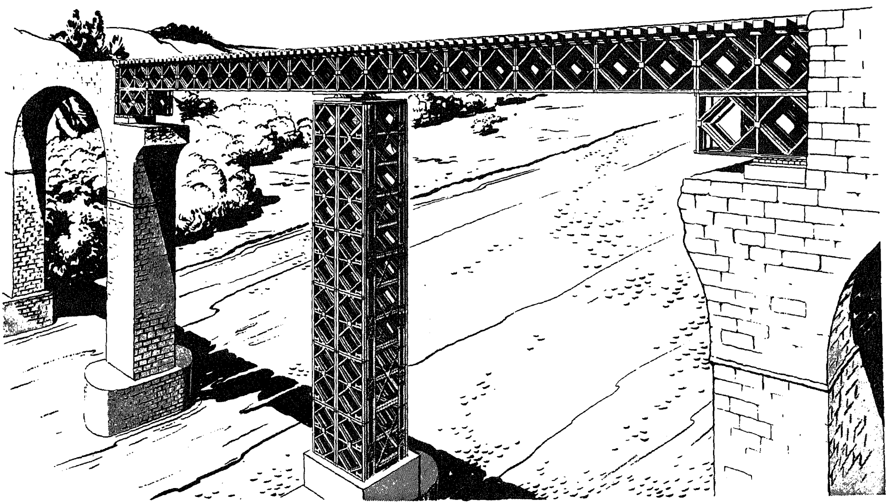


Figure 16–3. Panel bridge supported on various types of piers.

assembly is that the reaction on intermediate piers is less. In addition, pier settlement will not result in reduced bridge capacity, adjacent spans may be of any length, and seating operations are simplified. Existing piers of demolished structures (fig 16–1), panel crib piers, framed bents or cribs (fig 16–2), pile piers, or combinations of these (fig 16–3) are used for intermediate supports.

16–3. Assembly

a. Spans.

(1) Independent spans can be single-, double-, or triple-truss and single- or double-story assembly.

(2) If truss assembly is changed over the pier when using conversion set No. 3 (para 17–3), the heavier assembly should be continued for two bays into the lighter assembly to stabilize the junction link. For example, if a DS bridge is joined to a TS or DD bridge, the TS or DD should be continued for two bays past the junction into the lighter truss types. Keep transom clamps in these bays tight.

(3) If a triple-truss panel crib pier supports a double-truss bridge, distribute the load to all trusses in the pier by triple-truss assembly, and use three transoms over the pier and in three adjacent bays of each span.

b. Piers. Any type of supporting crib or pier capable of taking the end reactions of the spans can be used. Bailey-type panel crib piers for supporting broken-span bridges are described in chapter 17. It is desirable to make the top of all piers in the same plane as the abutments, but a change in slope between spans may be used if needed. High, narrow piers are guyed to prevent lateral movement.

c. Bridge Seatings.

(1) *With panel-crib-pier parts (conversion set No. 3).* Special care must be taken that piers are exactly alined and spaced so that the ends of two adjacent spans are on a common junction-link bearing. Attach span junction posts to the end of each span, and pin the posts to the junction links fitting in junction-link bearings. Bridge gap between two spans with junction chess. The use of standard conversion set No. 3 severely limits the bridge pier reaction.

(2) *Without panel-crib-pier parts.* If the panel-crib-pier parts are unavailable, attach the end posts to the ends of adjacent spans and seat on separate bearings (fig 16–4). Use any of the following three methods to bridge the gap between spans:

(*a*) *Junction chess.* If junction chess are used, seat an extra transom in the end posts of

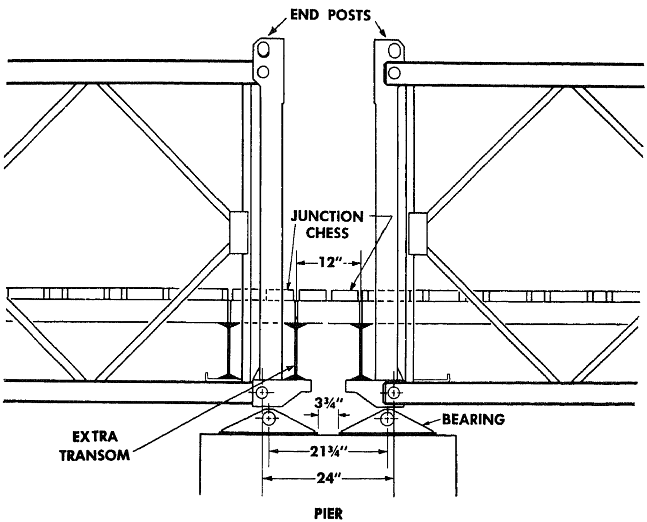


Figure 16–4. Bearings on pier at adjacent ends of two intermediate spans. Junction chess bridge the gap between spans.

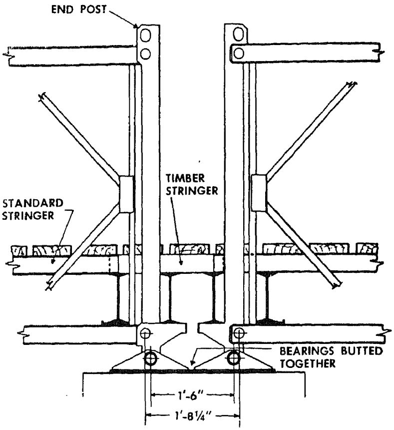


Figure 16–5. Use of 4- by 4-inch stringers 2 feet long to fill gap between end of spans.

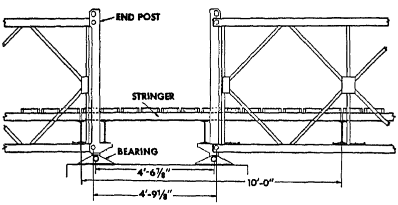


Figure 16–6. Two spans supported on a common pier. Gap of 5 feet left between ends of spans is bridged by offsetting stringers.

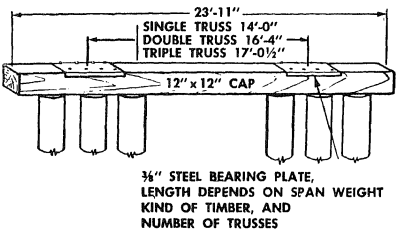


Figure 16–7. Construction of pile caps for intermediate supports under panel bridges without end posts or bearings. Cap for single timber or pile bent. Steel bearing plates provide seating for each line of trusses.

one span and space bearings 21¾ inches apart center to center (fig 16–4).

(*b*) *Timber stringers and chess.* If junction chess are unavailable, use seventeen 4- by 4-inch timber stringers decked with two chess. If bearings are butted against each other (fig 16–5), the stringers must be 2 feet long.

(*c*) *Cut stringers.* Standard stringers cut to the desired length can be used to bridge the gap between spans.

(*d*) *Standard stringers and chess.* If bearings are spaced 4 feet 6⅞ inches center to center, bridge gap by setting standard panel-bridge stringers back 5 feet along the bridge (fig 16–6). Use extra panels to support overhanging stringers at one end of the bridge.

(3) *Without end posts.* If end posts are not used, fasten steel plates to the pier cap for truss bearings. Pin only the lower chords of spans. Omit the top pin at junction so two spans can act independently.

(4) *On timber trestle or pile bents.* If timber trestle or pile bents are used as intermediate piers, construct the top of the bent as shown in figures 16–7 to 16–11. If end posts are not used, reinforce the cap sill with a steel bearing plate under each line of trusses. On single bents, use corbels with knee braces to provide a jacking platform for light bridges (fig 16–8). If double bents are used with end posts and standard bearings, lay timbers across caps to provide platform for seating bearings (fig 16–10 and 16–11). Group timbers together under each line of trusses.

16–4. Class

a. Normal Spans. Since spans of a broken-span bridge act independently, each span has the same class when fitted with end posts or span junction posts as a simple-span bridge of the same span length and type of assembly.

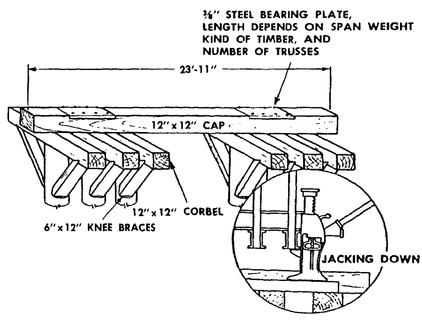


Figure 16–8. Construction of pile caps for intermediate supports under panel bridges without end posts or bearings. Corbels and knee bracing added to provide a jacking platform for light bridges.

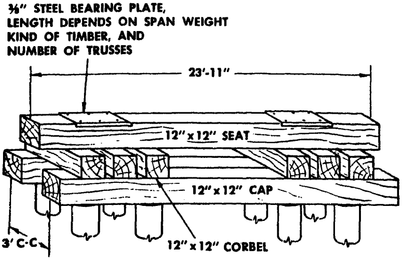


Figure 16–9. Construction of pile caps for intermediate supports under panel bridges without end posts or bearings. Cap for double trestle or pile bent.

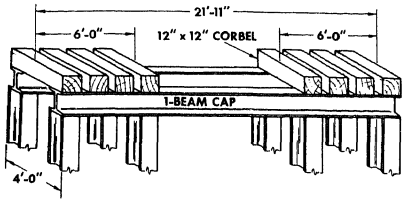


Figure 16–10. Construction of pile caps to provide seating for bearings at adjacent ends of independent spans—steel piles and caps.

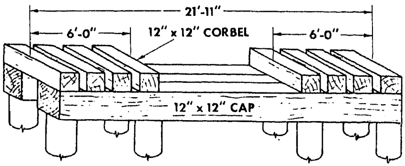


Figure 16–11. Construction of pile caps to provide seating for bearings at adjacent ends of independent spans—wood piles or trestle and cap.

b. Spans Without End Posts. If end posts or span junction posts are not used, the class of spans is limited. For classes of Bailey bridges without end posts, see table 24–3.

c. Piers.

(1) In a series of broken spans, the class of the weakest span is the class of the bridge. For classes of panel crib piers, see chapter 17.

(2) The load on a pier from two adjacent independently supported spans can be computed. The formula is based on a vehicle spacing of 100 feet. Allowing 15 percent of the live load for impact, and a coefficient of 1.13 for eccentricity, the total factor is 1.3.

$R = 1.3P + \frac{1}{2}W_d$

R = load in tons on pier.

P = maximum live load shear in tons.

W_d = total dead weight in tons of the two spans.

d. Example. The following example illustrates how to find the pier reaction of a broken-span bridge:

Given:

1. Spans of 130 and 80 feet on each side of an intermediate pier.
2. Broken-span panel bridge to span these gaps must carry class 50 load in normal crossing.

Required:

1. Determine bridge assembly needed.
2. Determine load on pier.

Solution:

1. Assembly: From table 5–1, the 130-foot span will require TD truss assembly and the 80-foot span DS truss assembly. The TD construction must be continued for two bays of the DS construction to stabilize the junction link.

2. Load on pier: Using the formula outlined above, P is determined from figure 16–12 by entering the bottom of the graph at 210 feet (total of the two spans), reading up to the class 50 curve and then to the left margin. In this instance P is determined to be 72 tons. To determine W_d refer to table 1–1 which shows that one bay of TD bridge weighs 5.88 tons and one bay of DS weighs 3.41 tons. The heavier construction must be continued two bays into the lighter construction. This results in 15 bays of TD and 6 bays of DS construction. By multiplication we find W_d is 108.66 tons. Load on pier is then—

$$
\begin{aligned}
R &= 1.3P + 1/2\ W_d \\
&= 1.3(72) + 1/2(108.66) \\
&= 93.6 + 54.33 \\
&= 147.9 \text{ tons}
\end{aligned}
$$

16–5. Methods of Launching

Broken-span bridges are launched by cantilevering the entire bridge with launching nose over the gap as a continuous bridge and breaking it; by launching each span by single girders; or by floating each span into position. See paragraphs 16–6 through 16–11.

16–6. Launching as a Continuous Bridge

Normally, an entire single- or double-story bridge with nose is launched over intermediate piers and then broken at the piers. Long, heavy single- or double-story bridges can be launched incomplete to make the launching easier. Connect the spans

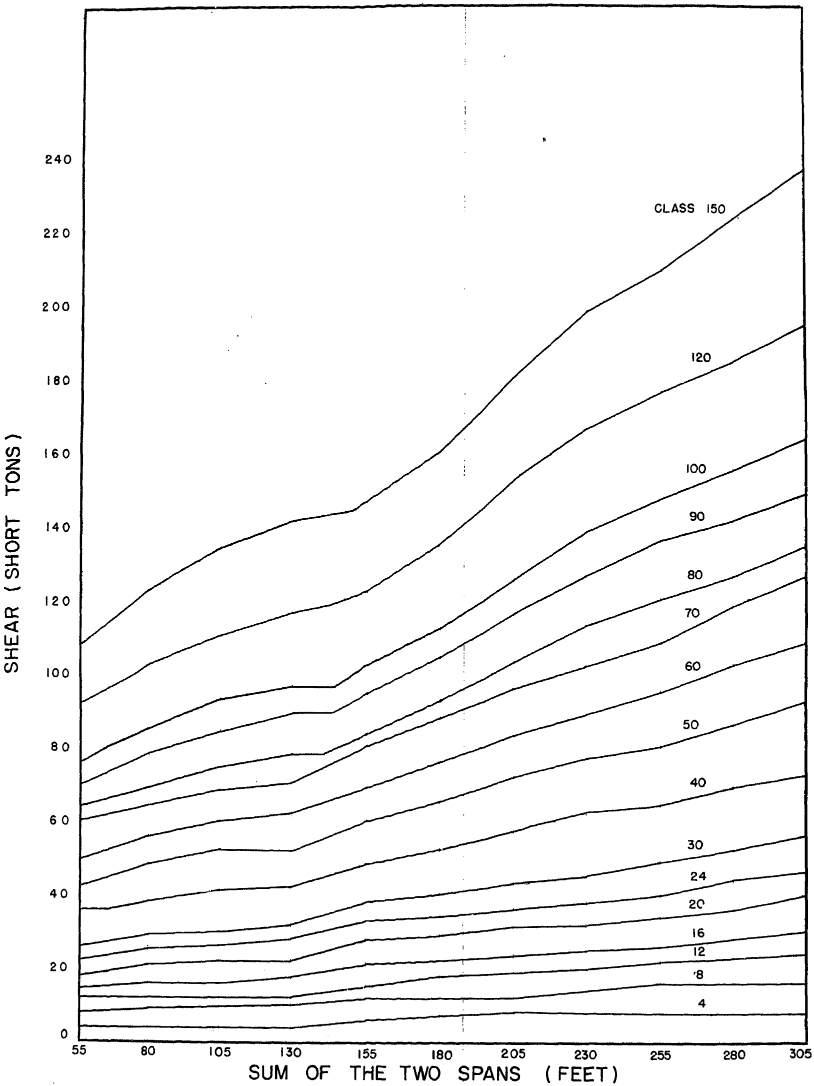


Figure 16–12. Standard class curves (shear 55'—305' spans).

directly or by span junction posts and launching links. Push the bridge across the gap or pull it across by winch line. In general, the following procedure applies in launching as a continuous bridge. Various techniques are discussed in paragraphs 16–7, 16–8, and 16–9.

a. Launching Rollers. Place launching rollers on each pier and on abutments in the same horizontal plane. Spike or lash rocking-roller bearings, base plates, or templates to piers to prevent shifting during launching. When span junction posts are not used and the bridge is to be cut over the pier, the pier top must be wide enough to allow the placing of two rocking rollers end to end under each truss.

b. Launching Nose. Use a launching nose in the same manner as for a normal bridge. The length of the launching nose should be the same as required for a single span bridge of the same length as the longest span in the broken-span bridge. Use launching-nose links in bottom chords of nose to compensate for sag. When estimating sag in nose to determine position of links, allow an extra 6 inches of sag for safety.

c. Guying Piers. During launching, guy piers to offset longitudinal thrust of bridge. When completely launched, pull bridge back slightly to relieve stress in guy lines if necessary.

d. Jacking Beams. Jacking down over intermediate piers requires jacking beams similar to those described in paragraph 16–19.

16–7. Spans With Span Junction Posts on Junction-Link Bearings

The following is the procedure for spans with span junction posts on junction-link bearings.

a. Making Junctions. Fit span junction posts to ends of spans and pin bottom jaws of adjacent posts together.

(1) If spans are all the same length, begin with first junction and fit alternate junctions with launching links between tops of span junction posts. This makes bridge continuous at these points. These junctions are called locked junctions. Do not connect top chords at other junctions.

(2) If spans are not all the same length, make first length of continuous bridge plus launching nose twice the length of the longest span. This counterweights the nose over the gap.

(3) In double-story assembly, place span junction posts in each story. Pin the bottom jaws of posts in lower story together and use Mk II launching-nose links to connect top of posts in top story. Do not make a pin connection between posts at top of lower story and bottom of top story.

b. Removing Pins and Jacking Down. Following are two methods of removing launching-nose links from top chords at locked junctions:

(1) *Removing launching-nose links at point of contraflexure.* For bridges with several long heavy spans, launching-nose links are removed at the point of contraflexure. In a continuous girder, there is a point near each support where the girder changes from a downward sag in the gap to an upward bend over the pier. At this point (point of contraflexure), there is no bending moment in the girder, no stress in links in the top chord, and panel pins are easy to remove. If the pins are heavily greased, they can be pulled by hand. To find the point of contraflexure in the span, station men at each link to test pins for slackness as soon as links are one-third span length from far pier. Push bridge ahead slowly and continue to test pins. When pins are loose, remove links. After removing links, continue launching until bridge is in final position over piers. Then, jack down bridge simultaneously at alternate supports.

(2) *Removing launching-nose links over piers.* For short light bridges of two or three spans, launching-nose links are removed over piers. Launch bridge completely before attempting to remove links. After launching, jack up ends of bridge and substitute cribbing at same height as rocking rollers at abutments. Then remove rollers and cribbing at each center pier and jack bridge down slowly. As jacks at center pier are lowered, tension in top chord decreases. When tension is zero, remove pins in Mk II links. Then jack bridge down on center pier. Repeat this procedure at adjacent piers, working toward abutments. See tables 16–1 and 16–2 for maximum lengths of bridge and jacking arrangements. For heavier bridges use jacks at the pier also.

16–8. Spans With End Posts on Standard Bearings

Following is the procedure for spans with end posts on standard bearings:

a. Launch as a continuous bridge until far span is in position.

b. Disconnect far span from rest of bridge, and pull bridge back until next span is in position. To remove the pins the bridge may be jacked up slightly either at the junction or at the end.

c. Repeat this procedure until all spans are disconnected over their piers.

Table 16-1. Maximum Lengths of Two Adjacent Spans of a Continuous Bridge that can be Jacked Over Intermediate Pier With Jacks Arranged as in Figure 16-19 [1]

Construction of spans	Two jacks under trusses at each side of bridge [2]				Four jacks under trusses at each side of bridge [3]				
SS:									
Short span	0-35	40	45-55		0-55	60-100			
Long span	(4)	60[5]	55[5]		(4)	100			
DS:									
Short span	0-55	60-70	75-90		0-80	85-140			
Long span	(4)	95[5]	90[5]		(4)	140			
TS:									
Short span	0-65	70-80	85-95	100-105	0-95	100-160			
Long span	(4)	115	110	105	(4)	160			
DD:									
Short Span	0-50	55-70	75-80		0-105	110-180			
Long span	(4)	85	80		(4)	180			
TD:									
Short span	0-40	45-55	60-65		0-95	100	105-120	125-135	140-145
Long span	(4)	70	65		(4)	160	155	150	145
DT:									
Short span	0-35	40-50	55-65		0-75	80-100	105-115	120	
Long span	(4)	65	60		(4)	130	125	120	
TT:									
Short span	0-30	35-45	47.5		0-60	65-75	80-90	95	
Long span	(4)	50	47.5		(4)	105	100	95	

[1] Based on dead weight of two spans over intermediate pier.
[2] Strength of jacks (15 tons) limits this jacking arrangement to a capacity of 56 tons except as noted in footnote 5. Truss spacing causes eccentric load on jacking beam.
[3] Strength of jacks limits this jacking arrangement to a capacity of 111 tons.
[4] As length of short span decreases, long span is limited by rule that short span must be at least 60 percent of length of long span.
[5] Based on 10-ton maximum concentrated load on panel chord between panel support points.

Table 16-2. Maximum Lengths of Two Adjacent Spans of a Continuous Bridge than can be Jacked Over Intermediate Pier With Jacks Arranged as in Figure 16-20 [1]

Construction of spans	Six jacks under trusses at each side of bridge [2]				Twelve jacks under trusses at each side of bridge [3]				
SS:									
Short span	0-55	60-100			0-55	60-100			
Long span	(4)	100			(4)	100			
DS:									
Short span	0-80	85-140			0-80	85-140			
Long span	(4)	140			(4)	140			
TS:									
Short span	0-95	100-160			0-95	100-160			
Long span	(4)	160			(4)	160			
DD:									
Short span	0-85	90-110	115-125	130-140	0-105	110-180			
Long span	(4)	150	145	140	(4)	180			
TD:									
Short span	0-65	70	75-85	90-100	0-115	120-200			
Long span	(4)	110	105	100	(4)	200			
DT:									
Short span	0-55	60-65	70-80	85-90	0-125	130-185	190-195	200	
Long span	(4)	100	95	90	(4)	210	205	200	
TT:									
Short span	0-45	50-55	60-70	72.5	0-95	100-110	115-125	130-140	145
Long span	(4)	80	75	72.5	(4)	160	155	150	145

[1] Based on dead weight of two spans over intermediate pier.
[2] Strength of jacks limits this jacking arrangement to a capacity of 84 tons. Strength of jack is 7.5 tons on toe. Truss spacing causes eccentric load on jacking beam.
[3] Strength of jacks limits this jacking arrangement to a capacity of 168 tons. Two ramps per side of bridge are required.
[4] As length of short span decreases, long span is limited by rule that short span must be at least 60 percent of length of long span.

d. Pin end posts to ends of spans, and jack spans down on bearings.

16–9. Spans Without End Posts

Following is the procedure for spans without end posts:

a. If bottom chords of all spans are to be pinned together and only top chords broken at piers, make junctions, launch bridge, and remove pins in same manner as for spans with span junction posts (para 16–7b).

b. If both top and bottom chords are to be broken at piers, launch bridge in same manner as for bridge with end posts (para 16–8).

16–10. Launching by Single Girders

In launching by single girders, assemble bridge by launching girders of each span from deck of previously completed spans. Add transoms and decking after girders are in place. For detailed procedure, see chapter 19.

16–11. Launching by Flotation

In launching by flotation, the span is assembled on rollers on the shore, launched onto pontoons or rafts, and floated into position between the piers. For detailed procedure, see chapter 18.

16–12. Jacking on Piers

In cases where it will be necessary to jack on intermediate piers, the distance through which the bridge has to be raised or lowered should be kept to the minimum by adjusting the levels of the intermediate rollers. In the case of flat cribs the jacking problem is considerably eased, since the jacks can be readily positioned under the inner trusses of the bridge. A satisfactory method of jacking the bridge off the intermediate rollers and positioning the distributing beams is as follows:

a. Place jacks beneath panel verticals or diagonals of the inner trusses on each side of the bridge with handles toward the center, and remove the sway braces. Lift the bridge clear of the rocking rollers, and remove rollers and cribbing. Place temporary cribbing under the inner trusses, and position the base plate with the bridge bearing placed centrally.

b. Place the distributing beams on the bridge bearings under the middle and outer trusses. Jack down to within 3 inches of the final position. Place cribbing between the bottom chords of the bridge and the top of the distributing beams and lower the bridge on to the cribbing. Remove the jacks from under the inner truss.

c. Put distributing beams centrally under the inner truss so that the crib bearing is over the bridge bearing.

d. Now place the jacks beneath the distributing beam under the inner truss of the bridge, jack up, remove the packing from the middle and outer trusses, and lower on to the bearings.

e. Weld the guide plates to the end stiffeners of the distributing beams, with the lug on the top of the plate between the middle and inner trusses.

f. Secure the bridge bearing in position in the base plate with timber.

16–13. Maintenance

Periodic checks are made to record any sinking of piers. Lateral shifting of the bridge is prevented by timber blocking on each side of bearings and lateral guy lines on high piers.

Section II. CONTINUOUS-SPAN BRIDGES

16–14. Features

A continuous-span bridge is one in which both upper and lower chords are continuous over intermediate piers between abutments. Advantages of continuous-span bridges are that siting of piers is not limited to 10-foot increments nor exact longitudinal alinement by panel junction as in broken-span bridges, assembly is faster, and class is increased for most types of assembly.

16–15. Class

Classes for continuous spans over piers are found in table 16–3.

16–16. Assembly

a. *Number of spans.* The number of spans is limited by two factors—effect of harmonious vibration set up by loads, and difficulty of keeping long bridges in alinement during launching. Normally, continuous-span bridges are limited to four spans or 500 feet.

b. *Length of Spans.* The maximum span of a continuous-span bridge to carry a specified load is given in table 16–3. The short span must be at least 60 percent of the length of the longer adjacent span. If the short span is less than 60 percent, a heavy load on the long span raises the end

Table 16-3. Classes of Bailey Bridge, M2 (Continuous Spans)

Span (ft)	Type of construction						
	SS	DS	TS	DD	TD	DT	TT
30	24						
40	20						
50	20	*65/65					
60	20	60/60					
70	16	50/55					
80	16	45/50	80/80				
90	12	40/45	70/70				
100	12	35/40	60/60	90/90*			
100		30/35	50/55	80/80	100*/90*		
120		20	40/45	65/70	90/90*		
130		16	30/35	50/55	80/80	90/90*	
140		12	24	40/45	60/65	75/80	
150			20	30/35	50/55	65/75	
160			16	24	40/45	60/65	80/90*
170				16	30/35	50/60	75/85
180				12	20	40/45	65/75
190					16	30/30	50/55
200							35/40

Construction Rules.
1. Equal spans are assumed.
2. The heavier construction of a longer span must extend beyond the intermediate pier at least 25% of the length of an adjacent shorter span.
3. Only the following changes of construction are permissible at an intermediate pier: SS to DS, DS to DD, TS to TD, DD to DT.

Notes.
1. *Limited by roadway width.
2. Upper figure represents wheel load class.
   Lower figure represents track load class. *Example* 50/55.
3. Single classification is designated below Class 30.
4. Bridges which have a normal rating over Class 70 must be constructed with double transoms.

Table 16-3. Classes of Bailey Bridge, M2 (Continuous Spans)—Continued

Classes for unequal span of continuous panel bridge, Bailey Type, M2

Spans (ft)	Types of construction								
	SS	DS		TS		DD		TD	
		Wheel	Track	Wheel	Track	Wheel	Track	Wheel	Track
50–30	20	70	70						
60–40	20	65	65						
70–40	16	55	60						
80–50	16	50	55	85	85				
90–60	12	45	50	75	75				
100–60	12	40	45	65	65	100*	90*		
110–70		35	40	55	60	85	85		
120–70		24		45	50	70	75	100*	90*
130–80		20		35	40	60	65	85	85
140–90				30	30	50	55	75	80
150–90				24		40	45	65	70
160–100						30	35	55	55
170–110						24		40	45
180–110								30	35
190 120									24

Notes.
1. Length of one span should be at least 60% of adjacent span and of the same type of construction.
2. Vehicles in convoy shall be spaced not less than 100 ft. between nearest points of deck work.
3. *Limited by roadway width.
4. Bridges which have a normal rating over class 70 must be constructed with double transoms.
5. Single classification is designated below class 30.

of the short span off its bearing. If spans less than 60 percent are essential, break the bridge at the pier to make the short span independent.

c. Change of Assembly Over a Pier. Changes in truss assembly are avoided when possible. If changes must be made, change number of stories rather than number of trusses to give better redistribution of stresses between adjacent spans. If one pier is used, the construction of both sides of the pier should be the same. Table 16–3 should be used for equal length spans and unequal length spans. If two or more piers are used in the assembly of continuous spans (*example* 120′, 120′ and 70′) the assembly may change over the last bay of bridge. To determine whether a change is permissible, table 16–3 must be checked to see if the lighter construction will give a class that is sufficient. Extend heavier assembly of longer span beyond intermediate pier a distance equal to 25 percent of shorter span. Make only the following changes of assembly between spans:

SS to DS
DS to DD
TS to TD
DD to DT

Wherever DD or DT truss types are used they must be reinforced to TD and TT respectively over a pier for two bays on each side of the pier-bridge connection.

d. Construction of Piers. Any type of supporting crib or pier capable of taking the reactions of the spans can be used. Piers are normally built before the bridge is launched over them. Where piers are inaccessible from the ground because of extreme height or rapid stream, a high line can be used in construction or the men and materials can be lowered from the end of the cantilevered launching nose of the bridge. Figures 16–13 and 16–14 illustrate how this has been done. On two-span bridges, the bridge may be launched across the gap and pier parts lowered from the bridge. The capacity of the bridge over the combined gap must be checked to insure that it will carry the pier construction crew and materials. High narrow piers are guyed to prevent lateral movement.

e. Construction of Bridge Seating. Some form of rocker bearing must be used at the intermediate pier to allow for deflection of girders under load. Normally, a rocker bearing for the bridge is placed at the top of the pier. If a rocker is placed at the base of the pier, the bridge can be fastened rigidly to the pier (chap 17). Various types of rockers at top of pier are described below. The distributing beam on the rocker bearing must be strong enough to prevent excessive local bending in the bottom panel chord. Table 16–4 gives the number of panel support points (points under panel verticals and junctions of panel diagonals) that must be effectively supported by the distributing beam to prevent excessive bending stress in the bottom chord.

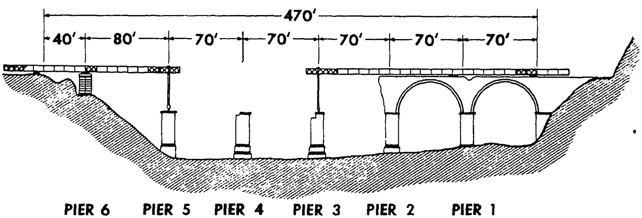


Figure 16–13. Piers 3 and 5 constructed from ends of bridge cantilevered out from each bank.

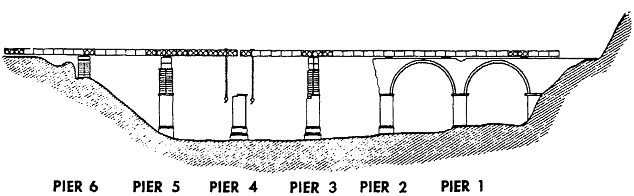


Figure 16–14. Pier 4 constructed from ends of bridge cantilevered out from each bank.

Table 16–4. Pier Reactions and Panel Support Points for Continuous Panel Bridge M2

Spans (ft.)		Types of construction						
		SS	DS	TS	DD	TD	DT	TT
30	A	46						
	B	2						
40	A	45						
	B	2						
50	A	47	115					
	B	2	3					
60	A	49	107					
	B	2	2					
70	A	52	106					
	B	2	2					
80	A	55	109	167				
	B	2	2	3				
90	A	61	117	172				
	B	3	3	3				
100	A	66	112	155	226			
	B	3	2	3	3			
110	A	----	107	148	205	279		
	B	----	2	2	3	3		
120	A	----	100	127	200	268		
	B	----	2	2	3	3		
130	A	----	99	128	194	268		
	B	----	2	2	3	3		
140	A	----	100	127	174	259	325	
	B	----	2	2	3	3	4	
150	A	----	----	121	174	248	309	
	B	----	----	2	3	3	4	
160	A	----	----	122	166	222	315	418
	B	----	----	2	3	3	4	4
170	A	----	----	----	161	209	318	413
	B	----	----	----	3	3	4	4
180	A	----	----	----	161	197	290	420
	B	----	----	----	3	3	4	4
190	A	----	----	----	152	190	276	383
	B	----	----	----	3	3	4	4
200	A	----	----	----	----	----	----	353
	B	----	----	----	----	----	----	4

A =Pier reactions (tons) at junction of two equal spans. Reaction at junction of unequal spans is average of reactions tabulated for two equal spans of each span length.
B =Number of panel support points to be supported by rocker bearings.

(1) *Rocker to support two panel support points.* Use a crib capsill, crib bearing, and standard bearing from the panel-crib-pier set as illustrated in figure 16–15. Because of the flexibility of the crib capsill, this rocker gives full support to only two panel support points. Pier reaction with this arrangement is limited to 17 tons per truss.

(2) *Rocker to support three panel support points.* Use a crib capsill, an inverted junction-link bearing, and a junction link from the panel-crib-pier set as illustrated in figure 16–16. Pier reaction with this arrangement is limited to 25 tons per truss.

(3) *Rocker to support five panel support points.* Reinforce the crib capsill in figure 16–15 with an 8-foot 4-inch section of transom as illustrated in figure 16–17. Weld capsill, transom, and crib bearing together and pin by chord clamps to panel chord. Weld small channels across bottom of transom sections at each side of bridge to give lateral stability to each rocker. Weld additional diaphragms and an end plate to the rocker bearing. The crib capsill may be omitted if a 10-foot section of transom is used, but end plates must be recessed to prevent lateral movement of the trusses being supported.

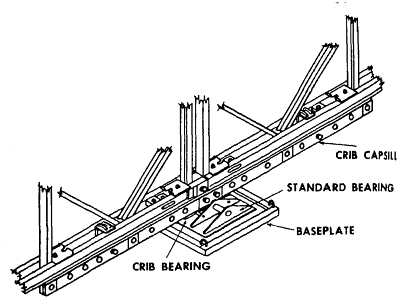


Figure 16–15. Rocker bearing to support two panel support points made from crib capsill, crib bearing, and standard bearing.

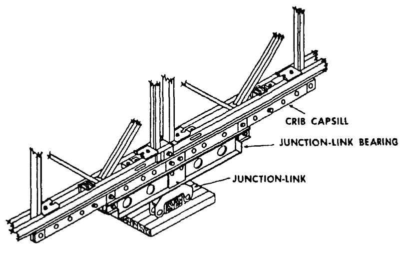


Figure 16–16. Rocker bearing to support three panel support points made from crib capsill, inverted junction-link bearing, and junction link.

f. Anchoring Bridge. Allowance must be made for slight longitudinal movement of the bridge due to deflection under loads, and for expansion and contraction due to temperature changes. With temperature changes of 60° F., a movement of ½ inch per 100 feet of bridge can be expected. To allow for this movement, grease base plates so bearings can move longitudinally on them. Restrain the bearings laterally with timber guides. If sloping bridges are erected, alternate expansion

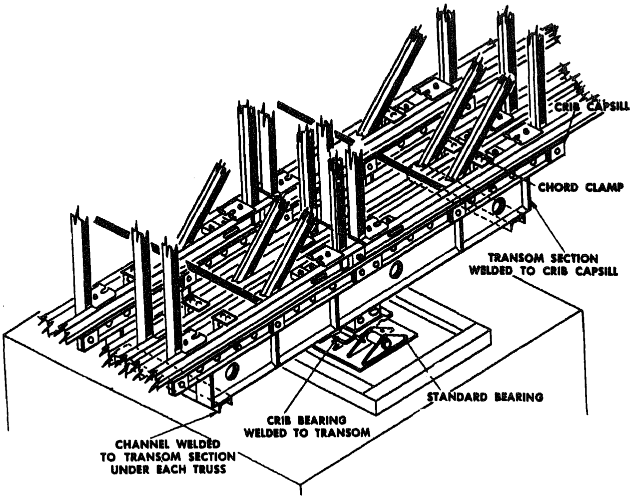


Figure 16–17. Rocker bearing to support five panel support points made from crib capsill, transom section, and crib bearing.

and contraction makes the bridge creep downhill. To offset this, keep slopes under 40 to 1 and fix one end of bridge to prevent creeping. At the end of a bridge with a short end span, lash or clamp end posts to bearings so posts cannot jump their seatings if end of bridge lifts when a heavy load is on the second span.

g. Leveling Supports. The bottom chord of the bridge must be in the same plane over all the intermediate supports. Normally, this plane is level, but a slight inclination is permissible. If any pier settles more than 6 inches below the bridge plane, then the rockers must be cribbed up. Without the cribbing, the superstructure will fail.

16–17. Pier Reaction

a. The class of continuous-span bridges varies with span lengths. For shorter spans it may be less than that of broken span bridges because shear at the piers is greater. Table 16–3 gives the capacities of continuous-span bridges. Note that in most cases the class is greater than it is for corresponding simple spans. Table 16–4 gives pier reactions and the number of panel points (points under panel verticals and junctions of panel diagonals) that must be supported by the rocker-bearing distributing beam to distribute stresses in bridge panels over the pier. The rocker bearing illustrated in figure 16–17 has a distributing beam long and stiff enough to support five panel support points and suitable for any of the spans in the tables.

b. The following example illustrates how to use this table:

Given:

1. Spans of 130 and 80 feet respectively on each side of an intermediate pier.
2. Continuous-span bridge to span these gaps must carry class 50 loads in normal crossing.

Required:

1. Determine bridge assembly needed.
2. Determine type of rocker bearing to use.
3. Determine load on pier.

Solution:

1. Assembly: From the second part of table 16–3 it is determined that DD truss construction will provide the desired class loading.
2. Rocker bearing: Table 16–4 shows three panel support points are required for two equal spans of 130 feet using DD construction. Since the 80 foot DD span is not given, the 100 foot DD span is used because this is the maximum reaction that can be generated on a DD truss. The panel support points required is again three; therefore truss of the girder must be supported under three panel support points (use bearing illustrated in figure 16–16).

3. Load on pier: Table 16–4 shows the pier reaction is 194 tons for two equal spans of 130 feet using DD construction. Again, since the 80 foot DD span is not shown, the length is taken as the worst condition, in this case 100 feet DD construction. The reaction under two such spans is given as 226 tons. The average of these two spans is used to determine the pier loading, which in this instance is 210 tons.

Note. To illustrate one advantage of continuous-span bridges over broken-span bridges refer to the example used in paragraph 16–4*d*. Span lengths and class requirements are identical; however, in broken-span construction a total of 15 bays of TD and 6 bays of DS construction are required to obtain class 50/55. In continuous-span construction a total of 21 bays of DD construction will suffice and provide class 60/65. Assuming panels are a critical item, the continuous-span bridge is more economical since it requires only 168 panels whereas the broken-span bridge requires 204 panels.

c. Another example of the use of the table is as follows:

Given:

1. Spans of 80 and 120 feet respectively on each side of an intermediate pier.
2. TS truss assembly.
3. Class 30 overall.

Required:

1. Determine type of rocker bearing.
2. Determine load on pier.

Solution:

1. Rocker bearing: Three panel support points must be used (table 16–4). Use bearing illustrated in figure 16–17 in order to support pier load.

2. Load on pier: Load on pier from two 80-foot TS bridges is 167 tons and load on pier from two 120-foot TS bridges is 127 tons. The average of the two is 147 tons.

16–18. Methods of Launching

Continuous-span bridges are launched by cantilevering the entire bridge with launching nose over the gap or by floating intermediate spans into position and then pinning.

a. With Launching Nose (fig 16–18). Length of launching nose required is the same as for simple-span bridge of the same length as the longest span in the continuous-span bridge. Use launching links to compensate for sag. When estimating sag in nose to determine position of links, allow an extra 6 inches of sag for safety. The launching procedure is as follows:

(1) Use plain rollers as in a single-span bridge. Place rocking rollers at each abutment and on top of each intermediate pier. Place rollers on intermediate piers in the same plane as near- and far-shore rollers, and spike or lash them to piers. Check level and alinement of rollers before starting bridge assembly.

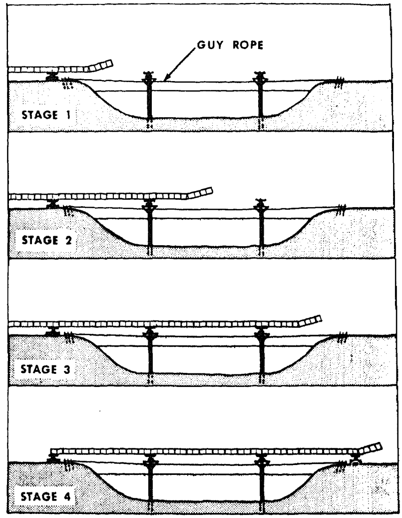


Figure 16–18. Launching a continuous-span bridge over intermediate supports with launching nose. Note guy line used to stabilize supports during launching.

(2) For long bridges, mechanical power may be needed to launch the bridge. Use methods described in paragraph 8–11. In addition, or as an alternative, use winch on far shore to pull bridge across gap. Careful alinement of bridge during early stages of launching is important.

(3) Long, heavy bridges can be launched incompletely to make the launching easier. Add extra trusses and decking needed to complete bridge after it is launched.

(4) During launching, guy piers to counteract forward thrust of launching. When bridge is completely launched, pull back slightly to relieve stress in guy lines if necessary.

b. By Flotation. Float intermediate spans into position as described in chapter 18. Lower and then pin to adjacent spans.

16–19. Methods of Jacking

a. Shore Ends. Jack down shore ends of bridges with jacks under end posts as described in chapter 7.

b. Intermediate Piers. At intermediate piers,

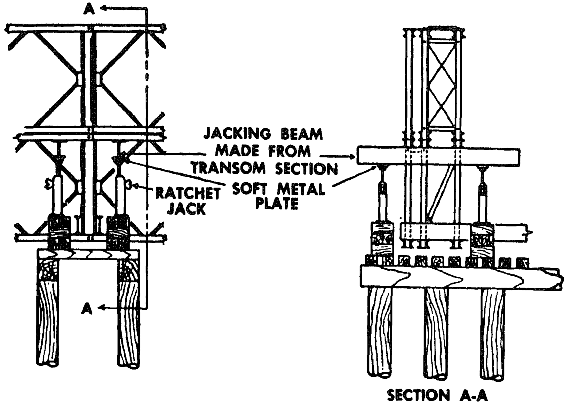


Figure 16–19. Jacking over intermediate pier—two jacks, one on each side of girder, push on beam under top chord of lower story.

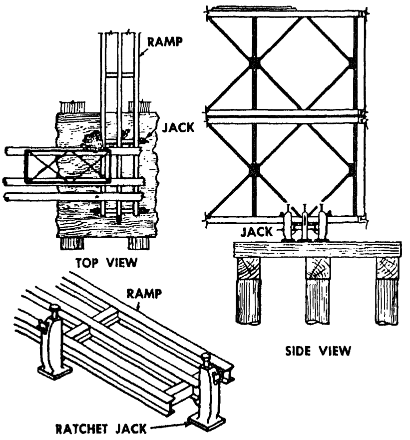


Figure 16–20. Jacking over intermediate pier—six ratchet jacks arranged under ramp section under lower chord of trusses.

expedient jacking methods must be used. Jacking load on toe of each jack must not exceed 7½ tons; jacking load on top, 15 tons. Also, jacks operated in unison must be of the same manufacture. Figures 16–19 and 16–20 illustrate two methods of jacking at intermediate piers. Tables 16–1 and 16–2 give lengths of adjacent spans of continuous-span bridge that can be jacked with these arrangements.

(1) Use two jacks, one on each side of trusses, under a section of transom under the top chords of the lower story (fig 16–19). A soft metal plate between the jack head and the transom eliminates danger of jack head slipping. Place transom section close to verticals of panels. Block under jacks to raise transom sections to level of top chord.

(2) Another method is to arrange six jacks under ramp section placed across under side of bottom chords (fig 16–20).

16–20. Maintenance

Pier sinking causes increased stress in the bridge and must be checked immediately by blocking or wedging under bridge bearings. Check ends of short spans for any tendency to lift off bearings. If end posts do lift off bearings, lash posts to bearings or break short end span at pier. Check anchorage to keep bridge from creeping under traffic. Maintain blocking to prevent lateral movement on piers.

Section III. CANTILEVER BRIDGES

16–21. Use

a. It is possible to use cantilever construction to produce clear span lengths greater than those obtained with conventional through-type construction. A clear span of 400 feet can be obtained using cantilever construction, but this span re-

and which would become too cumbersome.

b. The design data and information contained in this section are based on cantilever construction as shown in figure 16–21.

16–22. Design

a. Assumptions.

(1) Tables 16–5, 16–6, and 16–7 are based on a class 60 live load on a single lane, with a 14-foot roadway. The dead load is based on a panel weight with bracing of 600 pounds and an 8 inch wooden flooring weighing 400 pounds per foot. A single story truss was assumed capable of resisting 380 foot-tons, a double story truss 700 foot-tons, and a triple story truss 1310 foot-tons.

(2) An impact equal to 15 percent of the live load was used.

(3) The minimum number of trusses in both the simple span and the cantilever span was set at four. If less than four trusses are used the allowable capacities must be decreased due to excessive concentration of wheel loads on a truss, and the type of floor would have to be changed.

(4) The maximum number of trusses was taken at ten.

Span (ft.)	No. of trusses	Max. end reaction—tons LL + I + DL	No. of panels required
Single-story construction			
80	4	81.8	32
90	5	84.7	45
100	6	88.0	60
110	7	91.6	77
120	8	98.9	96
130	9	108.0	117
140	10	116.7	140
Double-story construction			
120	4	98.9	96
130	5	110.0	130
140	6	121.0	168
150	6	127.5	180
160	7	139.5	224
170	8	152.2	272
Triple-story construction			
180	5	147.4	270
190	5	153.3	285
200	6	168.1	360
210	7	184.0	441
220	8	200.7	528
230	9	218.4	621
240	10	236.9	720
250	11	256.1	825
260	13	289.0	1,014
270	18	836.4	1,296
280	20	397.8	1,680

Table 16–6. Number of Trusses Required in Suspended and Cantilever Spans (fig 16–21)

L	l	No. and type of trusses in Span #2	No. and type of trusses in Span #1, 3	l_1	l_2 Max.	l_2 Min.	Minimum no. of panels
100	80	4 single story	4 single story	10	80	80	104
110	90	5 single story	4 single story	10	80	80	117
120	100	6 single story	5 single story	10	90	80	130
130	110	7 single story	5 single story	10	90	80	167
140	120	8 single story	5 single story	10	90	90	136
150	130	9 single story	5 single story	10	90	90	217
160	140	10 single story	5 single story	10	90	90	240
170	150	4 triple story	6 single story	10	110	90	260
180	160	4 triple story	6 single story	10	110	100	294
190	170	4 triple story	6 single story	10	110	100	336
200	180	5 triple story	6 single story	10	110	100	402
210	190	5 triple story	6 single story	10	110	100	417
220	200	6 triple story	7 single story	10	130	100	514
230	190	5 triple story	10 single story	20	160	100	586
240	220	8 triple story	7 single story	10	130	110	686
250	230	9 triple story	7 single story	10	130	120	789
260	200	6 triple story	5 triple story	30	210	140	870
270	190	5 triple story	6 triple story	40	230	150	963
280	200	6 triple story	6 triple story	40	230	160	1060
290	210	7 triple story	7 triple story	40	240	160	1239
300	200	6 triple story	9 triple story	50	260	160	1440
310	190	5 triple story	10 triple story	60	270	160	1606

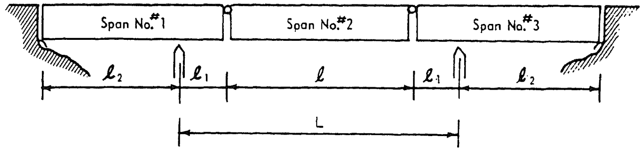


Figure 16–21. Cantilever construction.

Table 16–7. Number of Trusses Required in Suspended and Cantilever Spans—Using Equal Number in Both—(fig 16–21)

L	1	No. and type of trusses in Span #2	No. and type of trusses in span #1, 3	l_1	l_2 Max.	l_2 Min.	Minimum no. of panels
100	80	4 single story	4 single story	10	80	80	104
110	90	5 single story	5 single story	10	90	80	135
120	100	6 single story	6 single story	10	100	80	168
130	110	5 double story	5 single story	10	90	90	210
140	120	5 double story	5 single story	10	90	90	220
150	130	5 double story	5 single story	10	90	90	230
160	140	6 double story	6 single story	10	110	90	288
170	150	6 double story	6 single story	10	110	90	300
180	140	4 triple story	4 double story	20	130	120	392
190	150	4 triple story	4 double story	20	130	120	404
200	160	4 triple story	4 double story	20	130	120	416
210	170	5 triple story	5 double story	20	150	120	538
220	180	5 triple story	5 double story	20	150	130	570
230	190	5 triple story	5 double story	20	150	130	585
240	200	6 triple story	6 double story	20	160	130	720
250	190	5 triple story	5 triple story	30	210	140	795
260	180	6 triple story	6 triple story	40	230	150	1008
270	190	6 triple story	6 triple story	40	230	150	1026
280	200	6 triple story	6 triple story	40	230	160	1080
290	210	7 triple story	7 triple story	40	240	160	1281
300	220	8 triple story	8 triple story	40	250	160	1486
310	230	9 triple story	9 triple story	40	260	160	1701
320	240	10 triple story	10 triple story	40	270	160	1920

(5) The SALE charts for moment and shear have been used for those spans on which wheeled vehicles governed. Appendix F describes in detail the use of SALE charts in determining moment and shear. For spans of 120 feet and above the critical vehicle is the 60-ton tracked vehicle. A spacing of 100 feet from front to rear of a convoy of tanks moving across the spans gives a center of gravity of the loads at 114 feet center to center, and this was the maximum load used.

(6) A minimum safety factor of 1.15 was used against overturning of the cantilever span.

b. Tables.

(1) Table 16–5 gives the required number of triple-, double-, and single-story trusses which were used for the simple (suspended) span.

(2) Table 16–6 gives the various spans which can be built using cantilever-type construction. The combination shown is the most economical based on the number of panels required for the center to center pier spans (L) using the minimum length of anchor arm. It is important to note that there is both a maximum and a minimum length of anchor arm. The minimum length of anchor span provides the necessary counterweight for the cantilever arm and the bridge is stable if built in this way. However, the positive resisting moment of the counterweight span is not being utilized to its maximum capacity. The maximum span length shown provides for this utilization but if this length is exceeded, with proper loading, the section may fail.

(3) Table 16–7 gives combinations with the same number of trusses in both the cantilever and the suspended spans. These combinations are not as economical as those in table 16–6.

c. Design Example.

(1) Design of suspended span l (fig 16–21).

Assume $l = 190$ ft.

SALE = 66.7 tons.

$M_{LL} = PL/4 = 66.7 \times 190/4 = 3170$ ft tons.

$M_{LL} + M_I = 3170 \times 1.15 = 3650$ ft tons.

Estimated number of triple story trusses = 5.

$M_{DL} = [5(.09) + .2]\ 190^2/8 = 2930$ ft tons.

$M_{TOT} = 6580$ ft tons.

Actual number of trusses required = 6580/1310 = 5.

Therefore, 5 triple-story trusses will be used.

Maximum end shear:

$L.L. + I = 84 + .15\ (84) = 96.6$ tons.

$D.L.$ shear = 61.7 tons.

$\text{Shear}_{TOT} = 96.6 + 61.7 = 158.3$ tons.

(2) Design of cantilever span, l_1.

Assume single story construction with 6 trusses.

Try 10′–0″ span:

Resisting moment = $6 \times 380 = 2280$ ft tons.

$M_{DL} = [6(.03) + .2]\ 10^2/2 = 19$ ft tons.

End shear (on hinge) possible:

$P(10) = 2280 - 19 = 2261$ ft tons.

$P = 2261/10 = 226.1$ tons.

Therefore, this construction and span length is suitable to carry end shear of suspended span of 118 tons.

(3) Design of minimum anchor span, l_2.

$w = 6(.03) + .2 = .38$ ton/ft

$$\frac{wl_2^2}{2} = 2280 \text{ ft tons}$$

(R_1 assumed = 0)

$$l_2 = \sqrt{2280 \times 2/.38}$$
$$= \sqrt{12{,}000}$$

$l_2 = 109.5$ ft (Try 100 ft)

overturning moment about $R_2 = \frac{wl_1^2}{2} +$

$Pl_1 = 19 + 158.3\ (10) = 1602$ ft tons

Resisting moment about $R_2 = \frac{wl_2^2}{2} =$

$$\frac{.38\ (100)^2}{2} = 1900 \text{ ft tons}$$

safety factor = 1900/1602
= 1.18

(within 1.15 assumed allowable)

Therefore, l_2 minimum = 100 ft

(4) Design of maximum anchor span, l_2 (fig 16–22).

Max. resisting positive moment = 2280 ft tons.

Assume span = 110′–0″.

$SALE_{LL} + SALE_I = 58 \times 1.15 = 66.7$ tons.

$$R_1 = \frac{66.7\ (55) - 61.7\ (10) + .38\ (110)\ (55) - .38\ (10)\ (5)}{110}$$

= 48.4 tons

Moment at center $= 48.4 \times 55 - \frac{.38 \times 55^2}{2} = 2085$ ft tons

Therefore, maximum $l_2 = 110$ ft.

The total maximum length of bridge for this particular combination is then $l + 2(l_1) + 2(l_2)$ equals 190 + 20 + 220 = 430 ft. The pier to pier span length — $L = l + 2(l_1) = 20 + 190 = 210$ ft (table 16–6).

Note. Although 6 single-story trusses would be able to carry more than the maximum end shear of 158.3 tons on a cantilevered 10′–0″ span, an examination of steps (3) and (4) would show that they are necessary to satisfy even the minimum length of anchor span required.

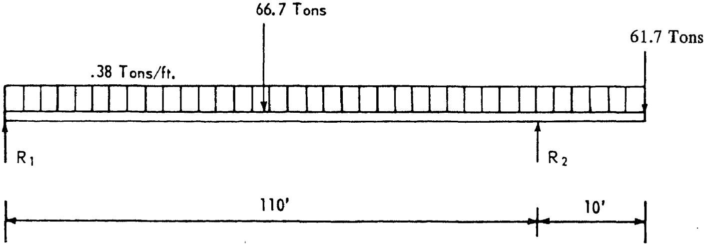


Figure 16–22. Loads and reactions.

CHAPTER 17

PANEL CRIB PIERS AND TOWERS

17–1. Use

Panel crib piers assembled from parts of the Bailey bridge set can be used as—

a. Intermediate supports for through- and deck-type fixed bridges. The piers can be set on timber grillage, piles (fig 17–1), masonry footings (fig 17–2), or partially demolished piers.

b. Piers in barge bridges.

c. Intermediate landing-bay piers in floating panel bridges with double landing bays.

d. Expedient towers for suspension bridges, lift bridges, gantries, and floating-bridge anchor cable systems.

e. Expedient marine piers.

17–2. Design

Panel crib piers are made of trusses with panels set horizontally or vertically and are normally braced with transoms, sway bracing, rakers, bracing frames, and tie plates in a panel bridge.

17–3. Types of Crib

a. Nomenclature. Panel crib piers are described by—

(1) Number of trusses (single, double, triple, and so on, as in a panel bridge).

(2) Number of stories (number of panels along the vertical axis in one bay as in the panel bridge).

(3) Number of bays (number of panels along the horizontal axis in a given story).

(4) Position of panels in each story (horizontal or vertical).

b. Abbreviations. Table 17–1 lists the abbreviations used to describe typical panel crib piers.

c. Number of Trusses. Panel cribs have from one to four trusses on each side depending on the desired capacity. There must always be at least as

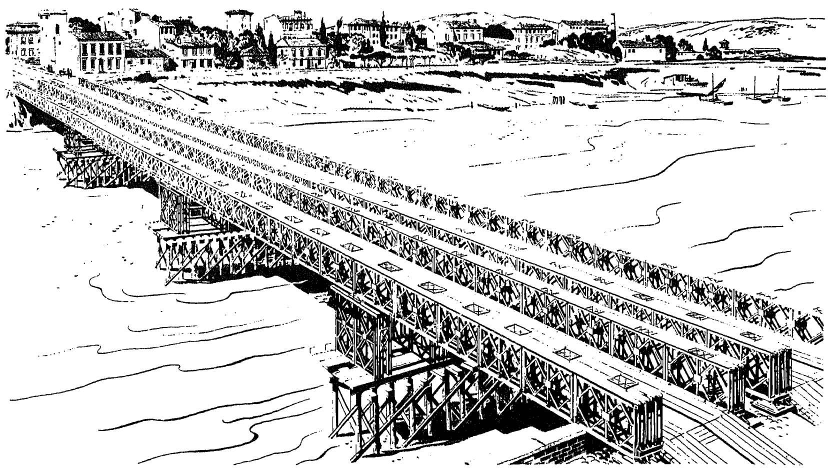
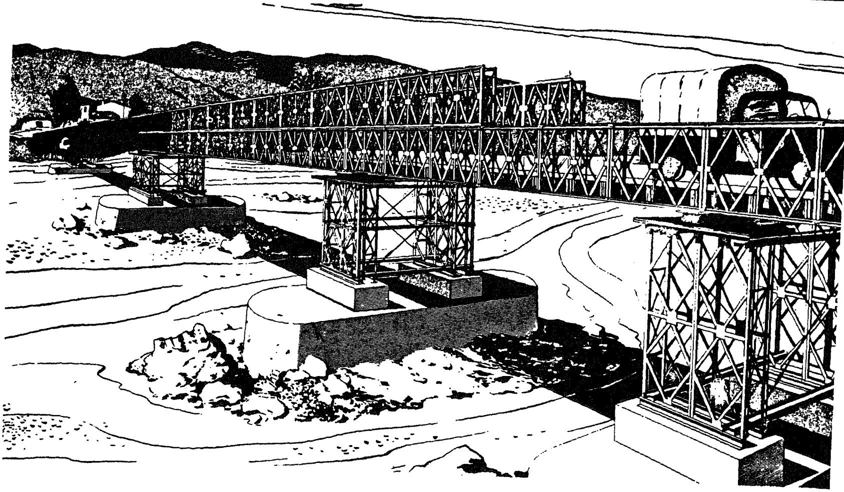


Figure 17–1. Two continuous panel bridges with panel crib piers on pile piers.

Table 17–1. Abbreviations Used to Describe Panel Crib Piers

Type of pier								
Number of trustees	Number of stories	Number of bays and panel positions						Abbreviation
		1st story	2d story	3d story	4th story	5th story	6th story	
Single	Single	One-horizontal						SS (1H).
Double	Single	One-vertical						DS (1V).
Double	Single	Two-vertical						DS(2V).
Triple	Single	Two-vertical						TS(2V).
Quadruple	Double	One-horizontal	One-vertical					QD(1H–1V).
Double	Double	One-vertical	One-vertical					DD(1V–1V).
Double	Double	Two-vertical	One-horizontal					DD(2V–1H).
Double	Double	Two-vertical	One-vertical					DD(2V–1V).
Double	Double	Two-vertical	Two-vertical					DD(2V–2V).
Quadruple	Double	Two-vertical	Two-vertical					QD(2V–2V).
Triple	Triple	Two-vertical	Two-vertical	Two-vertical				TT(2V–2V–2V).
Double	Quadruple	Four-vertical	Four-vertical	Two-vertical	Two-vertical			DQ(4V–4V–2V–2V).
Triple	Five	Four-vertical	Four-vertical	Two-vertical	Two-vertical	Two-vertical		T5(4V–4V–2V–2V–2V).
Triple	Six	Two-vertical	Two-vertical	Two-vertical	Two-vertical	Two-vertical	Two-vertical	T6(2V–2V–2V–2V–2V–2V).



Figures 17–2. Continuous panel bridge with panel crib piers on concrete footings.

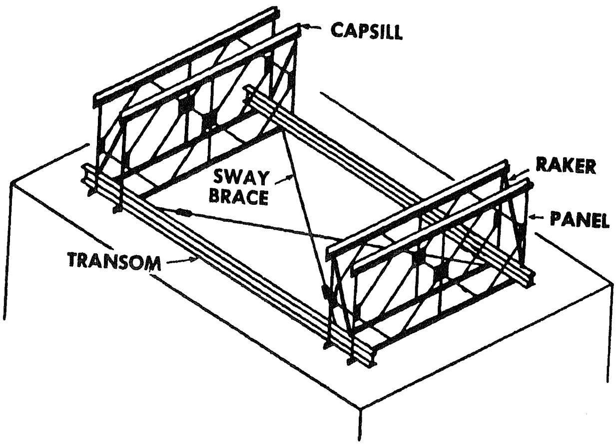


Figure 17–3. Panel crib pier, DS (1H) panel crib pier with panels horizontal.

many trusses in the crib as in the bridge it supports.

d. Number and Position of Panels. Panels in a panel crib pier are horizontal (fig 17–3) or vertical (fig 17–4).

(1) Horizontal panels provide 5-foot 1-inch increment in pier height. They are, however, weak laterally and are used one above the other when expedient bracing is added. When ultimate capacity piers are used any horizontal stories are weaker than vertical ones.

(2) Vertical panels provide 10-foot increments in pier height. They can be used one above the other in piers up to 70 feet high supporting continuous spans and up to 110 feet supporting broken spans. In high piers, exceeding three verti-

junction-link bearings by use of span junction posts and junction links (fig 17-5).

(2) *Expedient.* As an expedient, the adjacent ends of the two spans can be pinned to the vertical panels in the pier, or the two ends can rest on separate bearings.

17-5. Special Parts for Panel Crib Piers

The bridge conversion set number 3, Bailey type, panel crib pier, contains parts that are used with equipment from the basic bridge set to build panel crib piers. The major items in the conversion set are listed as follows:

Part	*Weight (lb)*
Female span junction post	202
Male span junction post	194
Junction chess	149
Junction link	36
Junction-link bearing	217
Chord clamp	11
Crib capsill	251
Crib bearing	37

Figure 17-5 to 17-17 illustrate uses of the special parts.

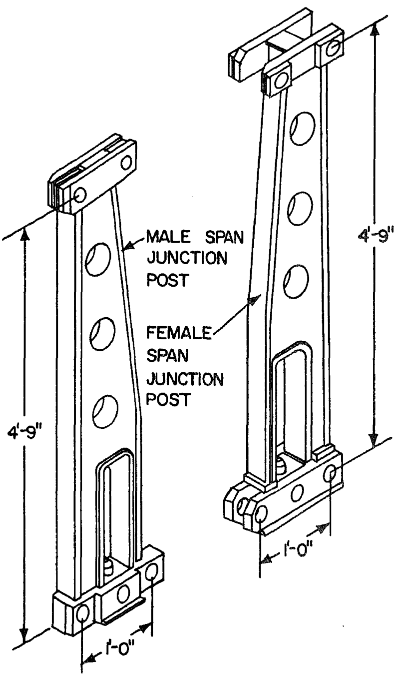


Figure 17-6. Span junction posts.

17-6. Span Junction Posts (fig 17-6)

a. Use. Span junction posts are special end posts for connecting adjacent ends of two spans and supporting them on the same bearing.

b. Description.

(1) There are two types of span junction posts, male and female, which have lugs that are pinned to female and male ends, respectively, of standard panels. At the junction, each post has two other connecting lugs, a male and female lug at the top according to type, and a universal jaw at the base. Irrespective of type, two posts can be connected at the base by a normal panel pin. A bridge pin retainer must always be used on the panel pin at this joint. An intermediate pin hole and recess in the base of each post is for the junction link.

(2) During launching, the top lugs of the posts are connected by a launching link Mk II. The launching link Mk II will only fit between one female span junction post and one male span junction post, and care must be taken when constructing the two spans to keep all the male lugs on the panels faced the same way. After the bridge is jacked down and posts are pinned to the junction link, the launching link Mk II is removed. The pin joining the two posts at their base is left in. Then the gap between the two lugs of the posts allows an upward slope of 6.7 to 1 or a downward slope of 5 to 1 in one span when the other is level. The female span junction post weighs 202 pounds, and the male span junction post weighs 194 pounds.

17-7. Junction Chess (fig 17-7)

a. Use. Junction chess span the gap in the bridge floor between the ends of the two spans connected by span junction posts. Four-junction chess are used at each span junction.

b. Description. The junction chess consists of two 6-foot 10½-inch timbers fastened to nine steel I-beams 11½ inches long. The junction chess weighs 149 pounds.

17-8. Junction Link (fig 17-8)

a. Use. The junction link transfers the end reaction from two span junction posts to a junction-link bearing. Its use limits truss reaction to 25 tons per link.

b. Description. The junction link is a triangular-shaped steel assembly with two projecting male lugs on its top side spaced to pin with panel pins to the two-span junction posts. Both holes are elongated to permit some play in the joint. A

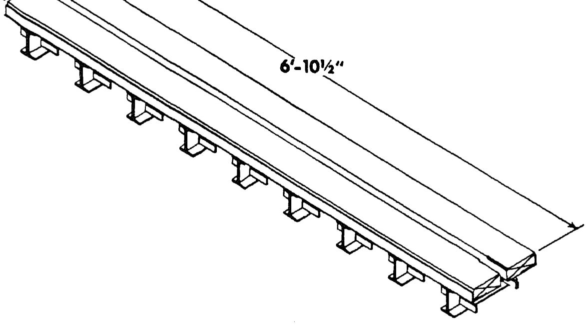


Figure 17–7. M2 junction chess.

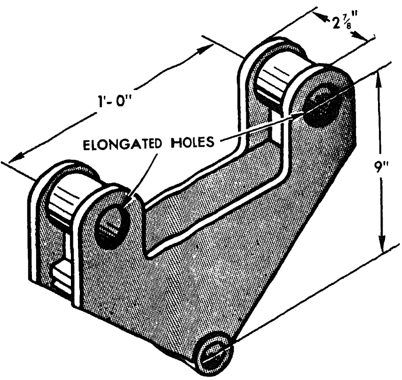


Figure 17–8. Junction link.

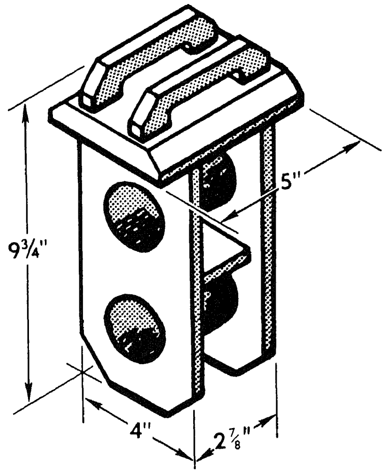


Figure 17–10. Chord clamp.

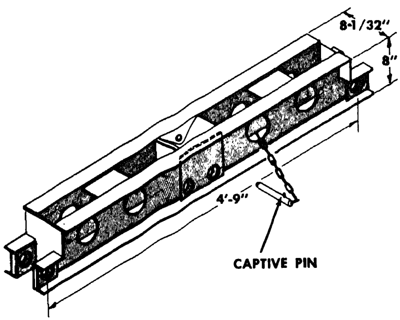


Figure 17–9. Junction-link bearings.

bridge pin retainer must always be used on the panel pins at this joint. The bottom of the junction link tapers down to a nose with a tubular bearing which seats in the curved bearing plate of the junction-link bearing and is held in place by a captive pin on the junction-link bearing. The junction link weighs 36 pounds.

17–9. Junction-Link Bearing (fig 17–9)

a. Use. The junction-link bearing is used under

the junction link which supports the ends of the bridge. It can be used in the following way:

(1) *Supported by a vertical panel.* If male lugs of the panel are uppermost, jaws of the junction-link bearings are pinned to the panel lugs. If female lugs are uppermost, the jaws of the junction-link bearing rest on top of the lugs and are fastened by chord clamps.

(2) *Supported by crib capsill (fig 17–5).* Chord clamps secure junction-link bearing to crib capsill.

(3) *Supported by crib bearing.* Crib bearing is pinned to two center holes of junction-link bearing with panel pins.

(4) *Used under female end of vertical panel.* Female lugs of panel rest on jaws of junction-link bearing and are secured by chord clamps.

(5) *Supported by timber.* Junction link bearing is laid directly on a timber support.

b. Description. The junction-link bearing is made of two 8-inch channels welded back to back with the same spacing as between channels in the chords of the panel. It is 5 feet 1 inch long and has female jaws at each end. The distance between panel-pin holes in the female jaws is 4 feet 9 inches, the same as vertical distance between pin holes in the panel. Between the webs of the channels in the center of the junction-link bearing is a curved bearing plate on which the junction link bears. There is a hole through the webs of the channels just above the curved bearing plate for a captive pin which locks the junction link in place. There are two panel-pin holes in the webs of the channels beneath the curved bearing plate. They are used to pin the crib bearing which fits in the recess between the channels. A junction-link bearing weighs 217 pounds. Its maximum capacity is 25 tons (table 17–2).

17–10. Chord Clamp (fig 17–10)

a. Use. The chord clamp is used to pin—

(1) Crib capsill to panel chord (fig 17–11).

(2) Crib capsill to female jaw of panel.

(3) Crib capsill to junction-link bearing (fig 17–5).

(4) Junction-link bearing to female jaw of panel.

b. Description. The chord clamp is in effect a double-length male lug with two panel-pin holes and a T-head. The clamp is slipped between the chord channels of a panel until the head bears on the channel flanges, then the clamp is pinned to a crib capsill or other female joint with a panel pin. If the chord clamp is slipped through two adjacent female jaws, it is pinned to each by panel pins through both holes in the chord clamp. The chord clamp weighs 11 pounds.

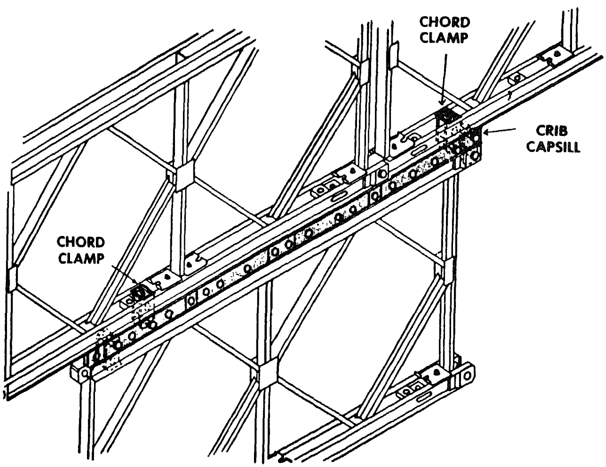
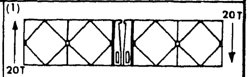
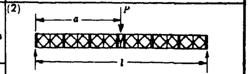
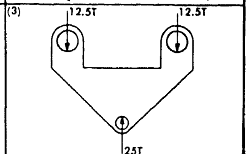
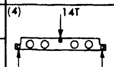
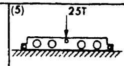
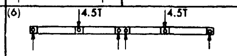
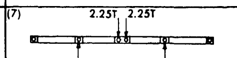
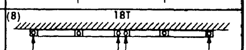
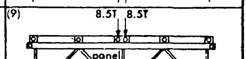
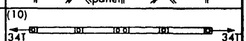
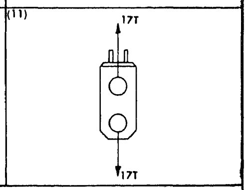


Figure 17–11. Use of crib capsill and chord clamps to connect horizontal panels of bridge and pier. Chord clamps are pinned to any of the holes in the capsill.

Table 17–2. Strength of Individual Panel Crib Parts

PART	LOAD	STRENGTH (TONS)	ILLUSTRATION
Span junction post	(1) Shear across joint	20	(1) 
	(2) Moment of resistance to bending when launching link MK II is in position: With no shear across joint	380 ft-tons	(2) 
	With 20 ton shear across joint	360 ft-tons	$\frac{Pa}{l}(l-a)=\begin{cases}380 \text{ ft-tons (no shear)}\\ 360 \text{ ft-tons (20 ton shear)}\end{cases}$
Junction link	(3) Vertical load	25	(3) 
Junction-link bearing	(4) Load at center when supported at ends only	14	(4)  (5) 
	(5) Load at center when supported for full length	25	
Crib capsill	(6) When supported at ends and center reinforced holes with load on two intermediate reinforced holes	9	(6) 
	(7) When supported at intermediate reinforced holes with load on two center reinforced holes	4.5	(7) 
	(8) When supported at end and center reinforced holes with distributed load	18	(8) 
	(9) When supported along entire length by a panel chord with load on two center reinforced holes	17	(9) 
	(10) Tension between any two reinforced holes	34	(10) 
Chord clamp	(11) Tension	17	(11) 

Note: See table 24-1 for strength of launching link MK 11, panel pin, panel, and bearing.

17–11. Crib Capsill (fig 17–12)

a. Use. The crib capsill distributes the load from the bridge to the main chords of vertical panels or to the three verticals of horizontal panels in a crib. It has unreinforced panel-pin holes used only to pin chord clamps (fig 17–11), and reinforced holes used to take the vertical load. Before panel pins can be inserted in reinforced holes, the holes must be reamed or filed slightly. The reinforced holes are used to pin the capsill to the following:

(1) Male lugs of single vertical panels.
(2) Male lugs of two adjacent vertical panels.
(3) Crib bearing (fig 17–13).

b. Description. The crib capsill is made of two 4-inch channels welded back to back to spacer lugs with the same spacing between channels as in the chord of the standard panel. It is 10 feet 2 inches

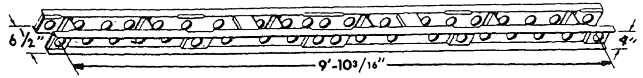


Figure 17–12. *Crib capsill.*

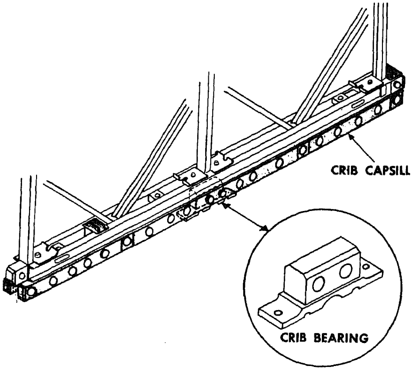


Figure 17–13. *Crib bearing under crib capsill.*

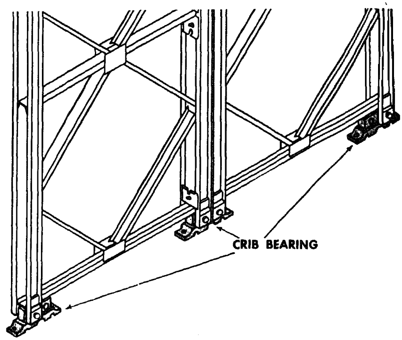


Figure 17–15. *Crib bearings pinned to one and to two adjacent female jaws of vertical panels.*

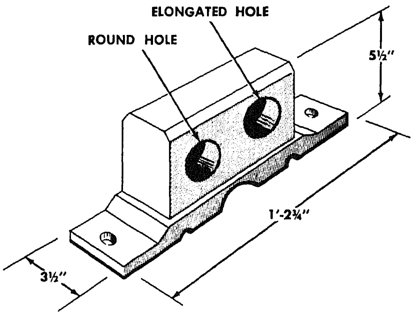


Figure 17–14. *Crib bearing.*

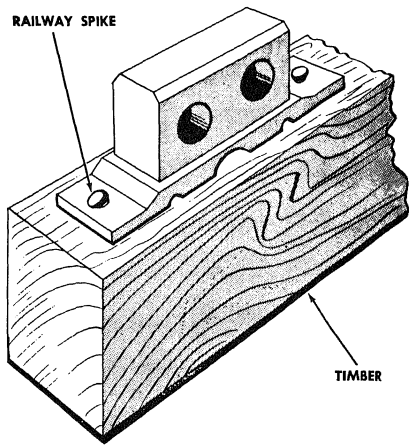


Figure 17–16. *Crib bearing spiked to timber sill to provide fixed bearing.*

long, and has female jaws at each end. Holes are spaced along the webs of the channels. Six pairs of panel-pin holes are reinforced with steel blocks and spaced so male lugs of two adjacent panels or of a single panel can be connected to the crib capsill with panel pins. Additional unreinforced holes for chord clamps are spaced generally at 6-inch centers between reinforced holes. Before panel pins can be inserted through the holes they must be reamed or filed slightly. The crib capsill weighs 251 pounds.

17–12. Crib Bearing (fig 17–14)

a. Use. The crib bearing is used as a base of panel cribs and can be pinned with panel pin to the following:

(1) One female jaw of vertical panel (fig 17–15).

(2) Two female jaws of adjacent vertical panels (fig 17–15).

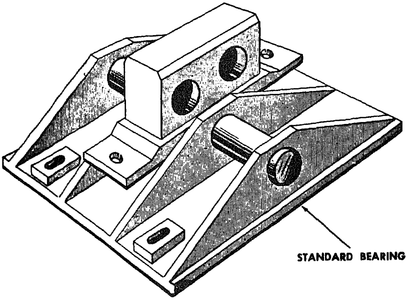


Figure 17–17. Crib bearing used with standard bearing to provide rocker bearing.

(3) Two central holes of a crib capsill (fig 17–13).

(4) Two central holes of a junction-link bearing. The crib bearing can be spiked to a timber sill (fig 17–16) to provide a rigid base or set on a standard bearing (fig 17–17) to provide a rocker bearing. The bearing area of the pin is $1.875 \times 3 = 5.625$ square inches.

b. Description. The crib bearing is in effect a double-length male lug welded horizontally to a base block. One of the pin holes is elongated to make pinning easier when both holes are used. If only one hole is needed, the circular one is used. Holes are provided in the base block of the crib bearing for spiking to a timber sill. The underside of the base block has a semicircular bearing to seat on a standard bearing. The crib bearing weighs 37 pounds.

17–13. Capacity

a. Load on Crib. Paragraph 16–4.c(2) describes a method for determining the approximate load transmitted to the crib by the ends of two independent spans. Continuous-span assembly over the pier transmits greater load to the pier. These reactions are listed in table 16–4.

b. Capacity of Crib.

(1) *With special panel crib parts.* Figures 17–18, 17–19, and 17–24 illustrate standard assembly of piers built with special panel crib parts. Capacities are given in all cases. Single-truss cribs can take 50 percent of the loads given for double-truss cribs with only the inner truss loaded. Single-truss cribs can be used only for light loads on low cribs. The capacity of panel crib piers is usually limited by the strength of the junction link, junction-link bearing, and crib capsill (table 17–2).

(2) *Without special parts.* If special panel crib parts are not used, the load is carried by the top members of vertical panels in the crib. Timber is laid on the top members of each panel so the load is concentrated at three points—at the center, and near each end adjacent to the panel chords. With the load applied in this manner, the top member of one vertical panel will carry about 14 tons, and piers with this type of bearing will have the same capacity as piers of corresponding assembly built with special parts (table 17–3).

Table 17–3. Capacity of Bridge Piers Assembled From Basic Bridge Set

Crib Pier	Bridge Continuous Over Support	Bridge Broken At Support
DS (1H)	70	100
TS (1H)	90	145
DS (1V)	60	80
TS (1V)	60	80
DS (2V)	90	100
TS (2V)	130	145

c. Strength of Parts. Table 17–2 gives the strength of the individual panel crib parts for use in estimating the capacity of expedient panel cribs.

17–14. Bills of Material

a. Table 17–4 lists the number of parts required to build the standard crib piers illustrated in fig-

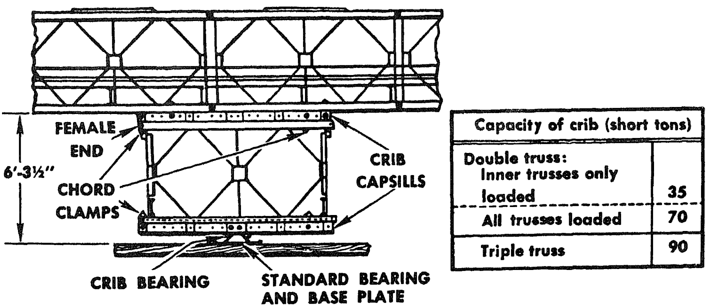


Figure 17–18. Single-story single-bay crib with panels horizontal. Continuous bridge with rocker bearing at base of crib using standard bearings.

Table 17–4. Equipment and Transportation Required to Build Standard Panel Crib Piers

1	2	3	4			5			6			7			8		9		
			Figure reference																
			17–18			17–19			17–20			17–21					17–22		
			Height																
			6′–3½″			7′–2½″			6′–6½″			17′–0″			27′–0″		10′–10½″		
			Type of construction																
Part	Unit weight (lb)	Basis for computing spares	SS (1H)	DS (1H)	TS (1H)	SS (1H)	DS (1H)	TS (1H)	SS (1H)	DS (1H)	TS (1H)	SD (2V–1H)	DD (2V–1H)	TD (2V–1H)	DT (2V–2V–1H)	TT (2V–2V–1H)	SS (2V)	DS (2V)	TS (2V)
			Number of parts required [1]																
1 Bearing [2]	68		2	4	4	--	--	--	--	--	--	--	--	--	--	--	2	4	4
2 Bearing, crib	37	10%	2	4	7	--	--	--	--	--	--	7	13	20	13	20	2	4	7
3 Bearing, junction-link	217		--	--	--	2	4	6	2	4	6	2	4	6	4	6	--	--	--
4 Bolt, bracing	1	25%	10	10	20	10	10	20	10	10	20	20	60	80	90	120	20	40	60
5 Bolt, chord	7.5	10%	--	--	--	--	--	--	--	--	--	4	9	13	18	26	4	9	13
6 Brace, sway, M2	68	10% to 4 max	2	2	2	2	2	2	2	2	2	7	7	7	11	11	4	4	4
7 Capsill, crib	251		4	8	12	4	8	12	2	4	6	4	8	12	--	12	2	4	6
8 Chess, junction, M2	149		--	--	--	--	--	--	4	4	4	4	4	4	4	4	--	--	--
9 Clamp, chord	11	10%	13	26	40	18	35	43	9	18	26	13	26	40	26	40	4	9	13
10 Clamp, transom	7	10% to 20 max	4	9	13	4	9	13	4	9	13	13	26	40	33	51	9	18	26
11 Frame, bracing	44	10%	--	--	--	--	--	--	--	--	--	--	9	9	13	13	--	4	4
12 Link, junction	36		--	--	--	2	4	6	2	4	6	2	4	6	4	6	--	--	--
13 Link, launching, Mk II [3]	28		--	--	--	--	--	--	2	4	6	2	4	6	4	6	--	--	--
14 Panel	577	10% to 10 max	2	4	7	2	4	7	2	4	7	7	13	20	22	33	4	9	13
15 Pin, panel [4]	6	20% to 50 max	24	48	72	29	58	86	34	67	101	58	115	173	134	202	19	38	58
16 Plate, base [2]	381		2	2	2	--	--	--	--	--	--	--	--	--	--	--	2	2	2
17 Plate tie	3.5	10%	--	--	4	--	--	4	--	--	4	--	--	9	--	13	--	--	9
18 Post, junction, span, female	202		--	--	--	--	--	--	2	4	6	3	4	6	4	6	--	--	--
19 Post, junction, span, male	194		--	--	--	--	--	--	2	4	6	2	4	6	4	6	--	--	--
20 Raker	22	10%	4	4	4	4	4	4	4	4	4	9	9	9	13	13	9	9	9
21 Transom, M2	618	10% to 4 max	2	2	2	2	2	2	2	2	2	7	8	8	10	10	4	4	4

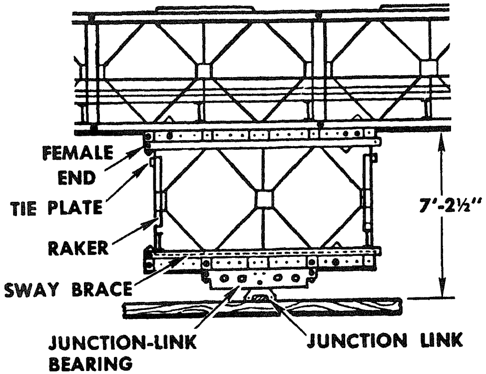
	Load number	Name of load	Number of loads required																
22	1	Parts load	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
23	2	Panel load	1	1	1	1	1	1	1	1	1	2	3	3	3	4	1	1	2
24	3	Transom load	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1
25	9	Crib-pier load	1	1	2	1	2	2	1	1	1	1	1	2	1	2	1	1	1

See footnotes at end of table.

Table 17-4. *Equipment and Transportation Required to Build Standard Panel Crib Piers*—Continued

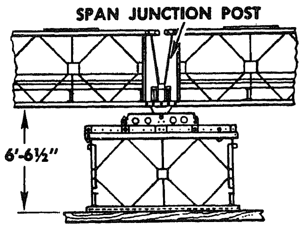
1	2	3	10		11		12			13		14		15		16	
			Figure reference														
			17–22				17–23							17–24			
			Height														
			20′–10½		30′–10½		11′–7			21′–7		31′–7		41′–7		51′–7	
			Type construction														
Part	Unit weight (lb)	Basis for computing spares	DD (2V–2V)	TD (2V–2V)	DT (2V–2V–2V)	TT (2V–2V–2V)	SS (2V)	DS (2V)	TS (2V)	DD (2V–2V)	TD (2V–2V)	DT (2V–2V–2V)	TT (2V–2V–2V)	DQ (4V–4V–2V–2V)	TQ (4V–4V–2V–2V)	D5 (4V–4V–2V–2V–2V)	T5 (4V–4V–2V–2V–2V)
			Number of parts required [1]														
1 Bearing [2]	68	---	4	4	4	4	---	---	---	---	---	---	---	---	---	---	---
2 Bearing, crib	37	10%	4	7	4	7	7	13	20	13	20	13	20	22	33	22	33
3 Bearing, junction-link	217	---	---	---	---	---	2	4	6	4	6	4	6	4	6	4	6
4 Bolt, bracing	1	25%	70	100	100	140	20	40	60	70	100	100	140	250	320	300	380
5 Bolt, chord	7.5	10%	18	26	26	40	4	9	13	18	26	26	40	70	106	79	119
6 Brace, sway, M2	68	10% to 4 max	9	9	13	13	4	4	4	9	9	13	13	26	26	31	31
7 Capsill, crib	251	---	4	6	4	6	2	4	6	4	6	4	6	4	6	4	6
8 Chess, junction, M2	149	---	---	---	---	---	4	4	4	4	4	4	4	4	4	4	4
9 Clamp, chord	11	10%	9	13	9	13	4	9	13	9	13	9	13	9	13	9	13
10 Clamp, transom	7	10% to 20 max	26	40	62	92	9	18	26	26	40	62	92	106	158	123	185
11 Frame, bracing	44	10%	9	9	13	13	---	4	4	9	9	13	13	40	40	48	48
12 Link, junction	36	---	---	---	---	---	2	4	6	4	6	4	6	4	6	4	6
13 Link, launching, Mk II [3]	28	---	---	---	---	---	2	4	6	4	6	4	6	4	6	4	6
14 Panel	577	10% to 10 max	18	26	26	40	4	9	13	18	26	26	40	53	79	62	92
15 Pin, panel [4]	6	20% to 50 max	58	86	77	115	46	91	137	110	166	130	194	187	281	206	308
16 Plate, base [2]	381	---	2	2	2	2	---	---	---	---	---	---	---	---	---	---	---
17 Plate tie	3.5	10%	---	13	---	18	---	---	---	---	13	---	18	---	31	---	35
18 Post, junction, span, female	202	---	---	---	---	---	2	4	6	4	6	4	6	4	6	4	6
19 Post, junction, span, male	194	---	---	---	---	---	2	4	6	4	6	4	6	4	6	4	6
20 Raker	22	10%	13	13	18	18	9	9	9	13	13	18	18	31	31	35	35
21 Transom, M2	618	10% to 4 max	7	7	15	15	4	4	4	7	7	15	15	26	26	31	31
Load number	Name of load		Number of loads required														
22 1	Parts load		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
23 2	Panel load		2	3	3	5	1	1	2	2	3	3	5	6	9	7	10
24 3	Transom load		1	1	2	2	1	1	1	1	1	2	2	3	3	4	4
25 9	Crib-pier load		2	2	2	2	2	2	2	2	2	2	2	4	6	5	6

[1] Quantities include spares as indicated in third column.
[2] These parts not supplied in loads needed to build pier. Use extras from bridge construction.
[3] Used for launching only. Removed after bridge is in place.
[4] Does not include pins for launching links Mk II when used.



Capacity of crib (short tons)	
Double truss: Inner trusses only loaded	50
All trusses loaded	100
Triple truss	145

Figure 17–19. Single-story single-bay crib with panels horizontal. Continuous bridge with rocker bearing at base of crib using junction-link bearings.



Capacity of crib (short tons)	
Double truss: Inner trusses only loaded	50
All trusses loaded	100
Triple truss	145

Figure 17–20. Single-story single-bay crib with panels horizontal. Bridge broken over crib.

ures 17–18 through 17–24, and the number of unit truck loads required to supply these parts.

b. Panel bridge conversion set No. 3, panel crib pier, supplies the special panel crib parts to build a 31-foot 7-inch TT (2V–2V–2V) pier with the addition of standard panel bridge parts. The parts in conversion set No. 3 are listed in chapter 3.

c. The conversion set No. 3 makes two crib-pier loads each carried by a 5-ton dump truck. These truck loads are described in chapter 3. The number of crib pier loads and standard unit truck loads required to build each pier is given in table 17–4.

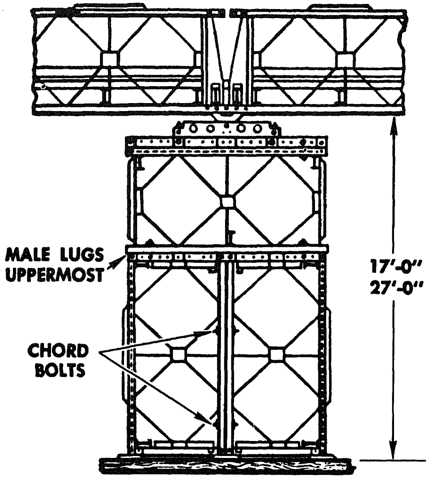
17–15. Standard Assembly

a. *Trusses*. The trusses in standard panel crib piers are parallel to trusses in the bridge. The crib must have at least the same number of trusses as the bridge it is to carry. More trusses through 17–24). Single-truss assembly can be used only for low cribs carrying light loads. The number of bays in the pier will normally be enough to make the length of the base one-third or more as much as the height of the pier (fig 17–24).

b. *Bracing*.

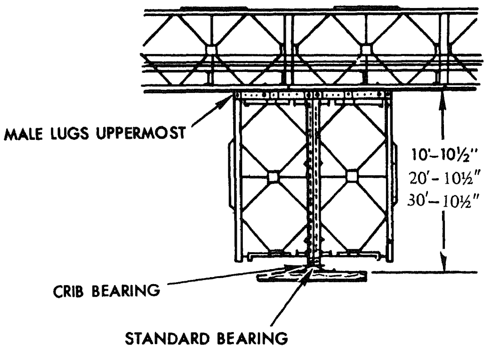
(1) All possible bracing frames and tie plates tie trusses together at each side of the crib. In a quadruple-truss pier, bracing frames and tie plates overlap. The entire crib is braced by transoms and sway bracing (fig 17–25).

(2) In cribs with vertical panels, transoms are spaced at 10-foot intervals in piers up to 30 feet. In cribs only one bay long, panels of inner trusses are inverted with respect to panels in outer trusses so transoms can be attached to both chords. Sway bracing is on the same side of the crib throughout its height. In cribs with two bays



Capacity of crib (short tons)	
Double truss: Inner trusses only loaded	50
All trusses loaded	100
Triple truss	145

Figure 17–21. Bridge broken over crib. Double- to triple-story double-bay crib with panels both horizontal and vertical. Double bay of vertical panels in bottom stories.



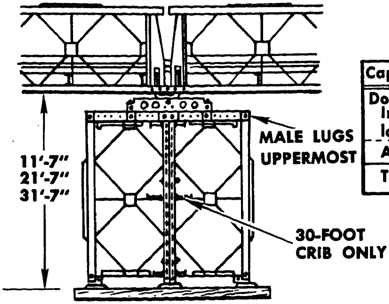
Capacity of crib (short tons)	
Double truss Inner trusses only loaded	45
All trusses loaded	90
Triple truss	130

Figure 17–22. Single- to triple-story double-bay with panels vertical. Continuous bridge with rocker bearing at base of crib.

and sway bracing are either at the center of the crib or at its sides. In cribs with four bays of vertical panels, extra sway bracing is added in the outer bays (fig 17–24).

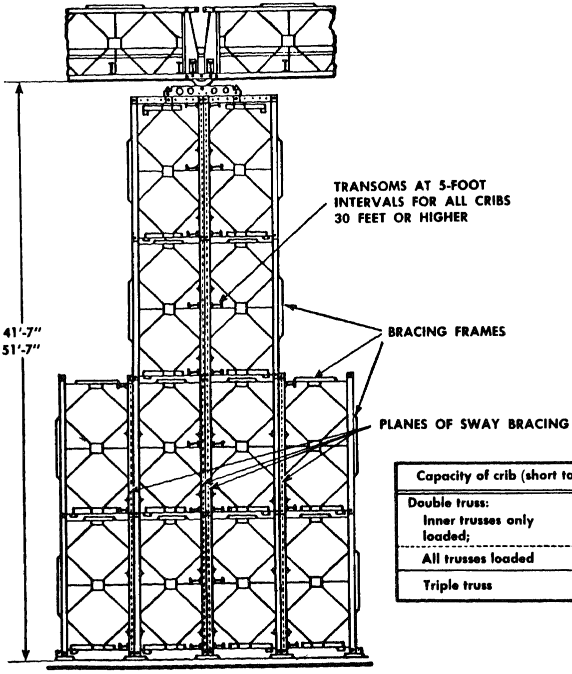
(3) In cribs with horizontal panels, half the panels may be right side up, and the other half inverted so transoms are at both top and bottom. Vertical plane cross bracing may be provided by sway braces pinned to the sway-brace slot of the inverted second truss and fastened to the transom at the other end, or the sway bracing may be used as described in paragraph 17–19b.

(4) In cribs under two-lane panel bridges, transoms are staggered at the center panels (fig 17–26). When panels are vertical transoms in one half under one lane, are all on top of panel verticals; in the other half under panel verticals. At the top and bottom of the crib, transoms can be placed only on the side of panel verticals. Therefore, angles must be welded to the panel chords to



Capacity of crib (short tons)	
Double truss: Inner trusses only loaded	50
All trusses loaded	100
Triple truss	145

Figure 17–23. Single- to triple-story double-bay with panels vertical. Bridge broken over crib.



Capacity of crib (short tons).	
Double truss: Inner trusses only loaded;	50
All trusses loaded	100
Triple truss	145

Figure 17–24. Four- to five-story crib with panels vertical. Four bays in two bottom stories and two bays in upper stories. Bridge broken over crib.

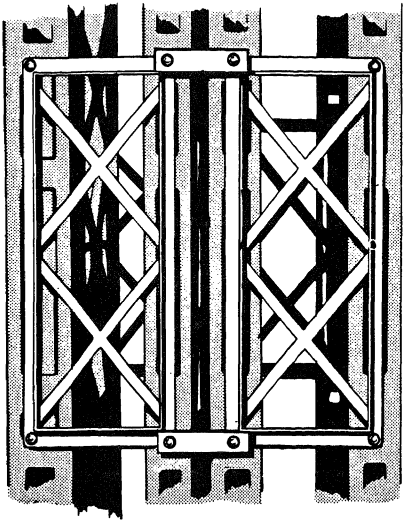


Figure 17-25. Close-up view of bracing in a quadruple-truss crib pier. Tie plates overlap bracing frames and are held by bracing bolts. Sockets are removed from tie plates and washers from bolts so extra long bolts are required.

take the place of alternate transoms (fig 17–26). When the panels are horizontal, angles are also used to place alternate transoms.

(5) High piers are guyed to provide additional lateral stability.

17–16. Bridge Seating

a. Broken Span. If the bridge is broken over the pier so the two spans act independently, span junction posts, junction links, and junction-link bearings are used (fig 7–5).

b. Continuous Spans.

(1) *Bridge fixed to top of crib.* If the crib is pivoted at its base so the bridge is fastened directly to the crib, chord clamps are slipped between the channels of the bridge chord and pinned to the crib capsill (fig 17–18 and 17–19).

(2) *Rocker bearing at top of crib.* Figure 16–15 illustrates rocker bearings using panel crib parts. This type of rocker bearing rests on a base plate on top of the pier. A wide platform on the top of the pier, to allow some leeway in positioning the base plates, may be constructed from transoms and ramps welded in place as described in paragraph 17–18*b*. An expedient rocker bearing may be made from one or two transverse beams set on the top of the pier. The bearing must be under a panel vertical or the junction of panel diagonals. Figure 16–16 illustrates another expedient bearing.

17–17. Crib Base

a. Fixed Base. If panels in the first story of the pier are horizontal, they may be set directly on a timber or masonry pier foundation (fig 17–20). If panels in the first story are vertical, the female jaws of the panels are pinned to crib bearings which are set on timber or steel footings (fig 17–23).

b. Rocker Base. The rocker may consist of crib bearing seated on a standard bearing (fig 17–17 and 17–18) or an inverted junction-link bearing set on an inverted junction link (fig 17–19).

(1) If the panels in the lower story of the pier are horizontal, a crib capsill is fastened by chord clamps to the bottom chord. This crib capsill is then pinned directly to the crib bearing (fig 17–18), or by chord clamps to the inverted junction-link bearing (fig 17–19).

(2) If there is one bay of vertical panels with female ends down in the pier, the female jaws are connected by chord clamps to the top of a junction-link bearing which is pinned to a crib bearing.

(3) If there are two bays of vertical panels, the two adjacent-center female jaws are pinned to a crib bearing which is on a standard bearing (fig 17–22).

17–18. Expedient Assembly—Standard Truss Arrangement

a. Improvised Panel-Crib Parts. If no special panel-crib parts are available, expedient parts can be improvised.

(1) *Expedient capsills.* Panel chords or any pair of 4-inch or larger channels with holes drilled at the desired spacing can be used for improvising crib capsills.

(2) *Expedient crib bearings for base of pier.* Angles or lugs with pin holes in their upright parts can be fastened to the crib foundation and panels pinned to them. Another expedient is to have the panel pins in the female jaws of the vertical panel bear on top of an I-beam or rail (fig 17–27). A load of 7½ tons per panel pin is allowed on unstiffened beams having a web thickness of ¼ to 5⁄16 inch. Greater loads are permitted if the web is stiffened or if the web thickness is greater than ⅜ inch.

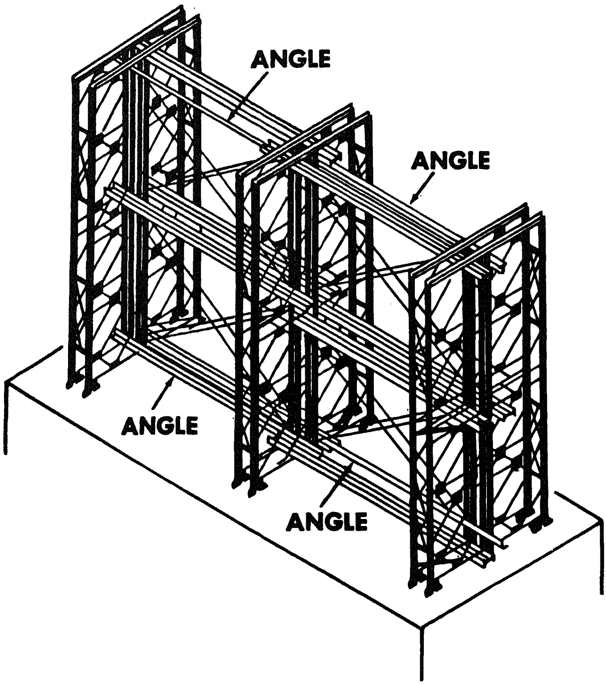


Figure 17–26. DD (2V–2V) panel crib pier for a DS–DD two-lane panel bridge. Transoms are stagged at center panels. At top and bottom, angles are welded to chords of panels in crib to replace alternate transoms.

(3) *Other parts.* Other special panel-crib parts are not readily improvised.

b. Assembly Without Panel-Crib Parts.

(1) *Bridge seating.*

(*a*) Figures 17–28 and 17–29 illustrate the use of transoms and ramp sections to provide a flat top in the crib for the base plates under the rocker bearing. With this type pier cap, the bridge may be as much as 6½ inches off the center of the pier. This is made up from a 4½ inch movement of the bearings on the base plate and a 2-inch movement of the base plate on the pier top. Figures 17–30 through 17–33 illustrate the vertical dimensions and capacities of piers with flat top and rocker ridge bearing.

(*b*) The bridge seating may consist of timber laid on the end-panel member in a lateral direction, but is allowed slight movement in a longitudinal direction.

(*c*) The pier can also be pinned to the bridge by pinning male lugs of the two inside posts of the pier to the lower bridge chord and inserting the outer posts in the space between channels of the lower chord. These outer posts just miss the center vertical in the bridge panels. If the outerpost shoulders are cut down enough to permit deflection in the span, this connection can be used with a rigid pier base. The top chord of the bridge is left unpinned so the two spans act independently.

(*d*) Another method is to insert the male lugs of the pier posts into recesses in the lower bridge chords. Clamps made from two tie plates and riband bolts anchor the bridge to the pier.

(*e*) The last three methods are limited because there is only one pier position in which the lugs fit without interfering with the bridge chord spacers.

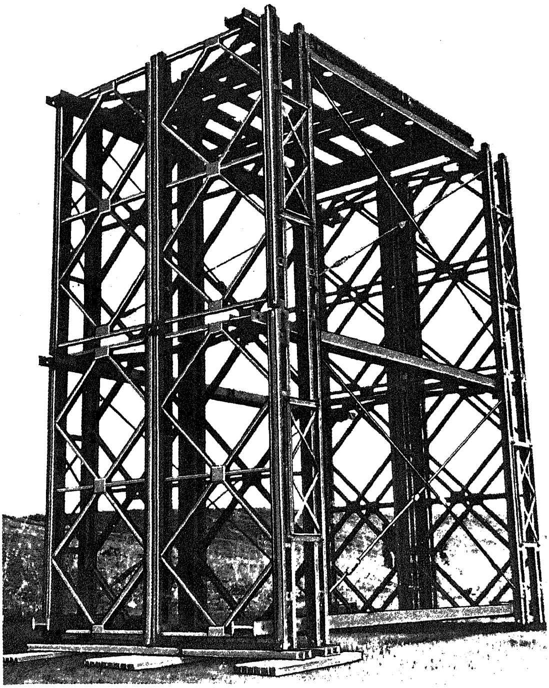


Figure 17–27. DD (2V–2V) pier.

(2) *Crib base.* Without special panel crib parts, the crib is set on timber. The cribbing is arranged to bear on the bottom panel member.

(3) *Connection between horizontal and vertical panels.* The reinforcing plate at the bracing-bolt hole is cut away, and the male lugs of the vertical panel are slipped between the channels of the horizontal chord. The panels are tied together by an expedient clamp made from tie plates and riband bolts (fig 17–34).

17–19. Expedient Assembly—Nonstandard Truss Arrangement

a. Trusses.

(1) *Panels transverse to axis of bridge.* Expedient panel cribs can be built with panels transverse to the bridge axis as in figure 17–35. This type of construction is useful when pier is skewed or when pier foundations are restricted. Two panels pinned end-to-end give a 20-foot pier width. In figure 17–35 trusses are braced together by bracing frames in every possible position. Bracing frames are overlapped at each end and 5-inch long bolts replace standard bracing bolts. In lighter one-story piers, the two panels are connected by tie plates.

(2) *Crib cells.* The crib may be built in the form of two cellular columns, one under each side of the bridge as in figures 17–36 to 17–38. Each column is made of four vertical panels arranged in a square. Chords of adjacent panels are welded to angles. Panels are capped with improvised cap-sills, and timber cribbing is laid across the cap-sills. The crib base is similarly constructed. The two columns are tied together by tie rods welded between them.

b. Bracing. More than one story of horizontal panels can be used if additional expedient vertical cross bracing is added.

(1) Figure 17–39 shows sway braces in the

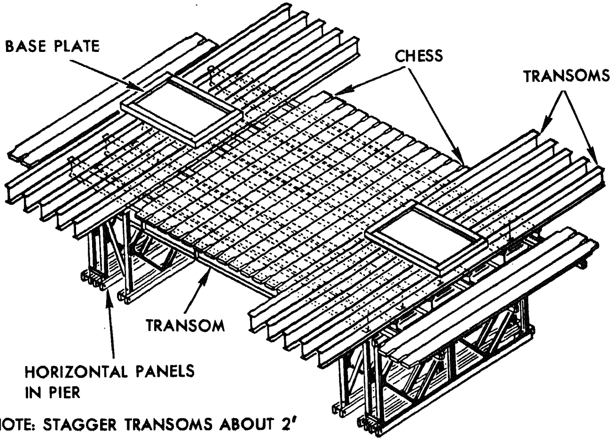


Figure 17–28. Expedient use of transoms and ramps to provide a flat top on the crib. TS(1H) panel crib pier.

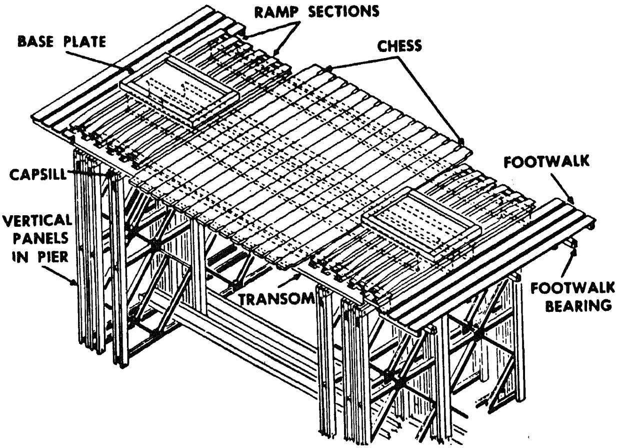
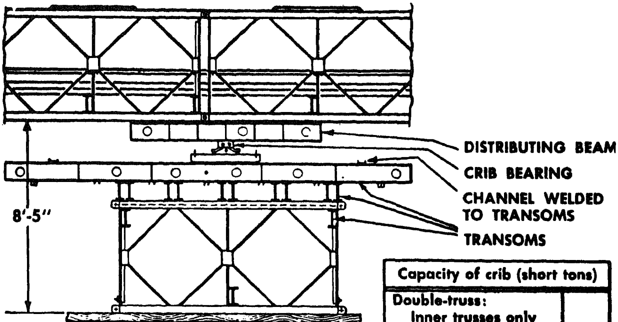


Figure 17–29. Expedient use of transoms and ramps to provide a flat top on the crib. TS(2V) panel crib pier.

vertical plane bracing a double-story pier to carry light loads. Tie plates are bolted to one end of the sway braces on an extension. Lengthened sway braces are bolted diagonally between the lower bracing-frame hole in the end vertical of one truss and the upper bracing frame hole of the end vertical on the opposite truss.

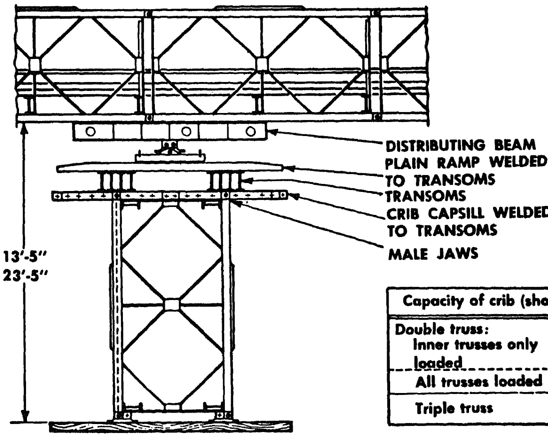
(2) As an alternative, vertical sway braces can be used in each story. The braces pin to the bottom chord of the second panel, bend up, and are welded to the underside of the top chord in the opposite inner truss (fig 17–40).

(3) For heavier loads, channel sections



Capacity of crib (short tons)	
Double-truss: Inner trusses only loaded	65
All trusses loaded	110
Triple truss	155

Figure 17–30. Panel crib piers with expedient flat tops and rocker bridge bearing under continuous bridge. Single-story single-bay crib with panels horizontal.



Capacity of crib (short tons)	
Double truss: Inner trusses only loaded	65
All trusses loaded	110
Triple truss	155

Figure 17–31. Panel crib piers with expedient flat tops and rocker bridge bearing under continuous bridge. Single- to double-story single-bay crib with panels vertical.

welded across each end of the crib give a more rigid cross brace (fig 17–40).

17–20. Assembly of Crib Pier

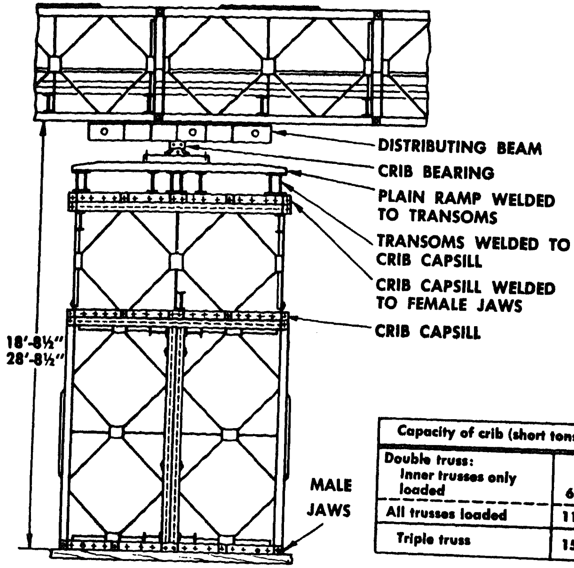
a. Without Equipment. The procedures below may be followed when erecting piers by manpower.

(1) Lay out and accurately level pier foundation. Mark panel positions accurately. Position crib bearings where these are used.

(2) Carry up panels for trusses on each side of crib and lay flat on base with female jaws pointing to bearings. Lift up panels and pin to bearings.

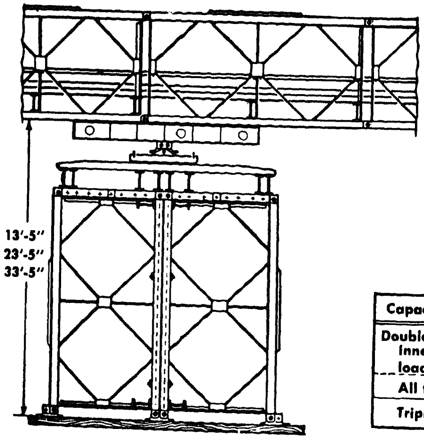
(3) Fasten transoms, rakers, bracing frames, and sway braces in first story. Check that the panels are vertical and square to center line.

(4) Construct a working platform of transoms and chess in the first story. Haul panels up



Capacity of crib (short tons)	
Double truss: Inner trusses only loaded	65
All trusses loaded	110
Triple truss	155

Figure 17–32. Double- to triple-story double-bay crib with panels both horizontal and vertical.



Capacity of crib (short tons)	
Double truss: Inner trusses only loaded	65
All trusses loaded	165
Triple truss	220

Figure 17–33. Single- to triple-story double-bay crib with panels vertical.

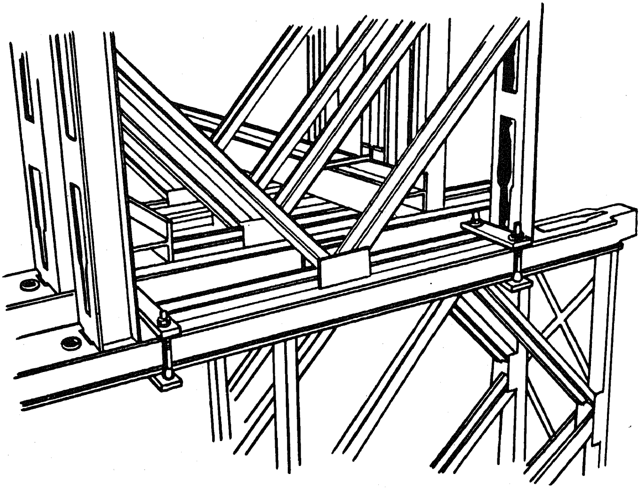


Figure 17–34. Expedient connection between horizontal and vertical panels in a panel crib pier. Reinforcing plate at the bracing-bolt hole is cut away, and male lugs of vertical panel are slipped between chord channels of the horizontal panel. Panels are tied together by an expedient clamp made from tie plates and rib and bolts.

singly and lay flat on platform with female jaws opposite top lugs of first story. Lift each panel in turn and pin into position.

(5) Fasten transoms and bracing in second story and again check that crib is vertical and square to center line.

(6) Repeat for number of stories required. An improvised gin pole or davit may be used to lift panels and transoms to upper stories.

b. With Mechanical Equipment.

(1) If site conditions permit, a truck-mounted crane can be used to erect 20-foot high crib piers and the two lower stories of high piers. Bays are assembled on the ground nearby, and the assembly is lifted into place by crane. For erecting higher piers, a long-boomed crane can be used (fig 17–41).

(2) If pier construction is between existing high banks or piers, cranes and high lines (fig 17–41) with winches on banks or existing piers can be used to lift panels into place.

(3) If the bridge without the pier will carry the erection equipment, the pier can be constructed from the bridge. A truck crane or rope tackle can be used to lower the panel over the side of the bridge into place on the pier. When all panels in the pier are in place, the bridge is jacked up over the pier to eliminate sag and allow placing of bridge seating. This last step can be eliminated by leaving the bridge on rollers at each abutment until after the pier is completed. Rollers must be blocked up enough to keep the bottom chord above the level of the top of the finished pier.

(4) In continuous-span bridges, the pier can be constructed by working from the end of a cantilever span.

17–21. Launching Bridge

Rocking rollers are placed on cribbing on top of the piers before launching the bridge (fig 17–42). The bridge is pushed out over these rollers until the entire bridge is over all the spans. The bridge is jacked up, rollers and cribbing are removed, and then the bridge is jacked down onto its seatings on the piers (fig 17–43). A temporary working platform may have to be built for operating the jacks (fig 17–44). If the bridge is to consist of independent spans, the girders are disconnected at each pier.

17–22. Jacking Down Continuous Spans

Where the distance through which the bridge has

to be raised or lowered is more than a few inches, jacking will have to take place on more than one pier at the same time. Since in this type of construction the whole girder is continuous, lifting through any distance progressively increases the length of bridge lifted, and thereby, the weight to be raised. This soon exceeds the capabilities of the jacks that can be brought into use on one pier. Where these conditions apply, a sequence of jacking on three piers at the same time, as described below, will be the easiest method to adopt. This consists of raising the bridge through a smaller

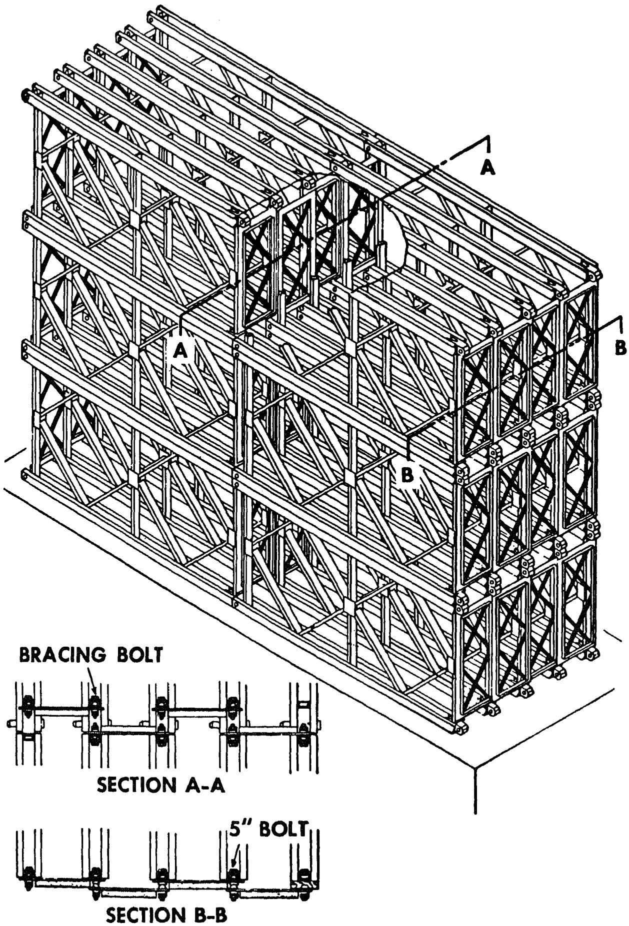


Figure 17-35. Expedient panel crib pier with panels transverse to axis of bridge.

distance on each of the piers adjacent to the one on which the distributing beams are being fitted. The procedure is as follows:

a. The ends of the bridge are first jacked up and lowered on to suitable cribbing slightly above final level. Three complete jacking parties are then required for the intermediate piers, working from the near bank and operating in the following sequence:

(1) The first party, working on the first pier, lifts the bridge clear, removes the rollers and lowers the bridge onto the cribbing, the height of cribbing being the same as that used at the end of the bridge.

(2) The second party does the same on the second pier while the first party jacks up on the first pier, fits distributing beams, and lowers the bridge to the original level (i.e., level of top of cribbing).

(3) The third party completes operation (1) on the third pier and the second party then fits distributing beams on the second pier. The first party then lowers the bridge on to the bearings of the first pier.

(4) The first party completes operation (1) on the fourth pier, the third party then fits distributing beams on the third pier, after which the second party lowers the bridge on to the bearings on the second pier.

b. This sequence is continued throughout the length of the bridge. It will be observed that by this means the bridge is raised by a slightly smaller amount on the two piers adjacent to the one on which the distributing beams are being fitted. Strict control of the jacking parties will be

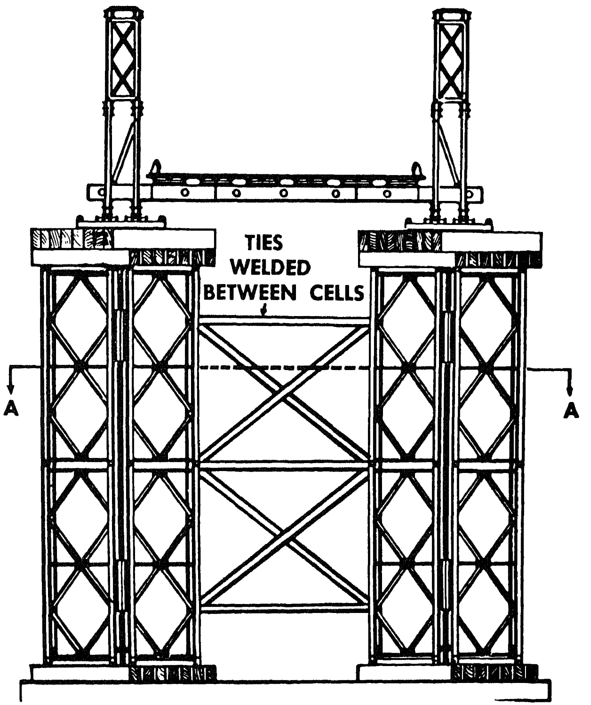


Figure 17–36. Cellular type panel crib pier. End view.

essential, however, to enable the distributing beams to be fitted on the center pier.

c. In the case of long bridges, it may be expedient to begin jacking on the center pier and work outwards towards the ends of the bridge. For this method, it will be best to employ six jacking parties, three working towards each bank adopting the sequence described above.

d. Where the distance through which the bridge has to be lowered is such that it cannot be achieved in three stages, the number of jacking parties should be increased accordingly.

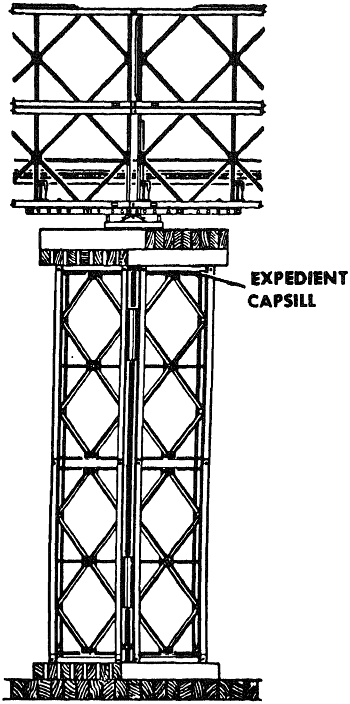


Figure 17–37. Cellular type panel crib pier. Side view.

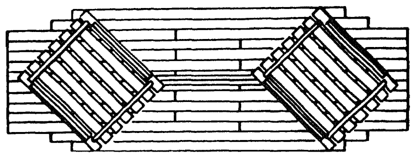


Figure 17–38. Cellular type panel crib pier. Section A–A.

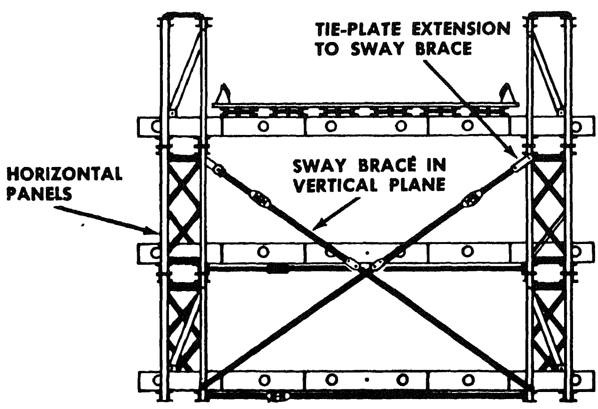


Figure 17–39. Sway-brace cross bracing in two-story panel crib pier.

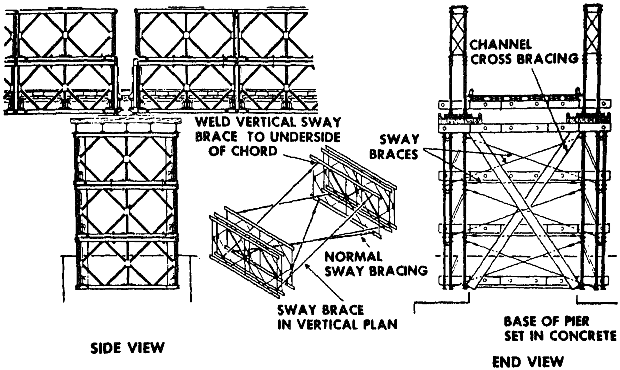


Figure 17–40. Expedient cross bracing in three-story panel crib pier.

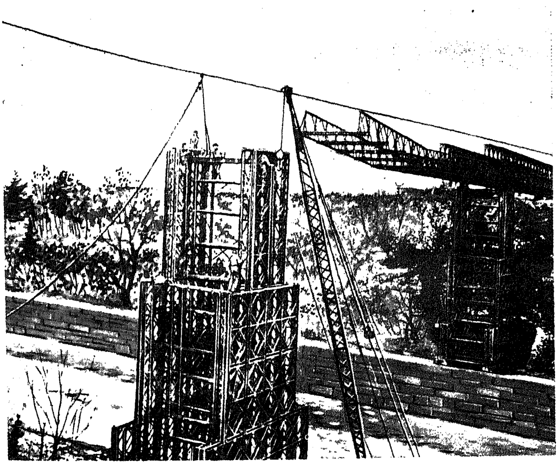


Figure 17–41. Erection of five-story panel crib pier using a highline and crane. These two five-story crib piers were built to support a 324-foot class 40 panel bridge.

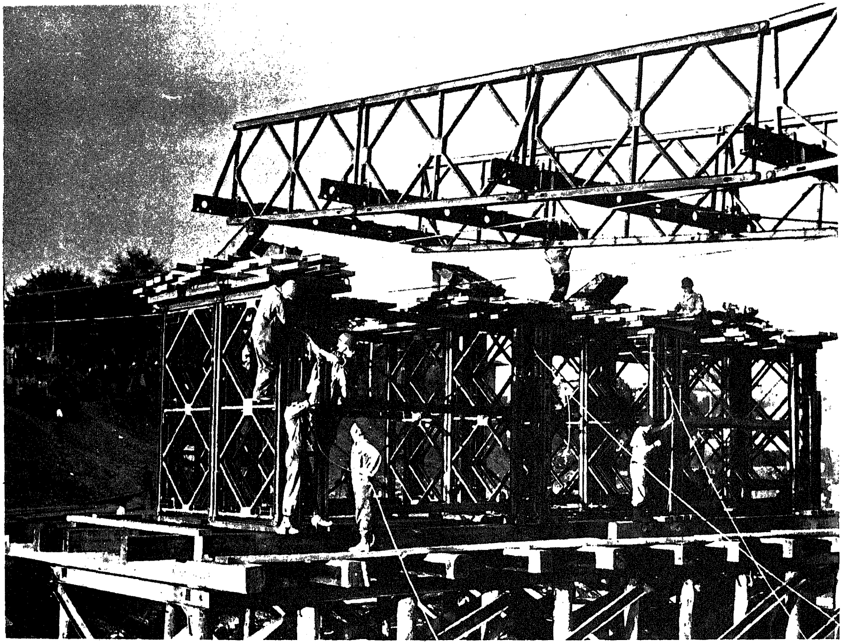


Figure 17–42. Rocking rollers in position on top of panel crib pier before launching bridge.

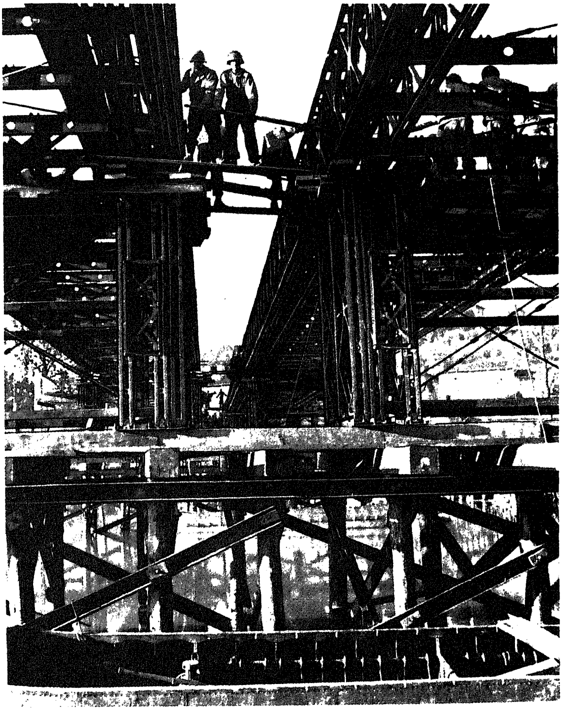


Figure 17–43. Two panel bridges being jacked down onto panel crib piers.

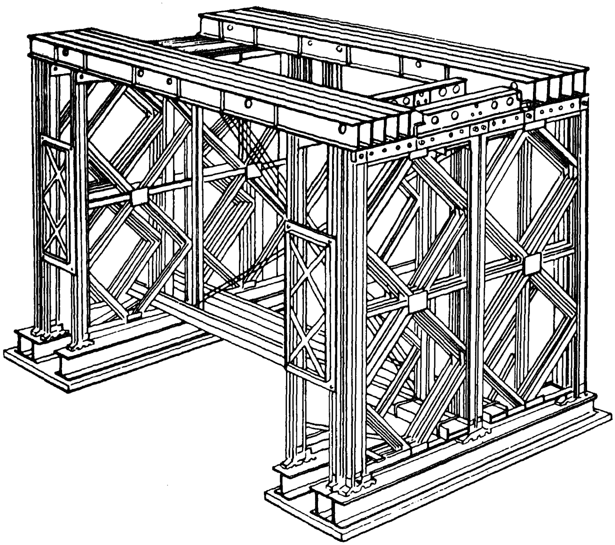


Figure 17–44. Temporary working platform made of transoms.

CHAPTER 18

SPECIAL LAUNCHING METHODS

18–1. Restricted Sites

a. Description. A restricted site prevents normal roller layout and launching by the standard skeleton launching nose method described in chapters 5 and 7. Space on either bank may be restricted in length or width by obstructions such as buildings, existing bridge girders, trees, and earthwork or by sloping banks and canal dikes. Limited backspace or length of assembly area on the near bank is the most common restriction. Backspace is measured from the near-bank rocking rollers to the limiting obstruction (fig 18–2). Far-bank conditions are a less common restriction because standard launching tables allow progressive dismantling of all launching noses and this requires a minimum clear distance of only 12 feet beyond the far-bank rollers. Several methods included in this chapter, however, reduce far-bank requirements even more by landing directly on bearings (para 18–3, 18–5, 18–6) and by inverting the nose assembly (para 18–4) to clear low obstructions such as existing girders.

b. Scope. This paragraph and paragraphs 18–2 to 18–6 describe launching of Bailey bridges using fixed and movable counterweights with—

(1) Standard launching nose assembly for a site with limited backspace on the near bank. Several bridge bays are omitted during launching. Counterbalance of the span is maintained by placing a counterweight in the last bridge bay equivalent to the missing bays.

(2) Launching tail assembly for sites with far-bank limitations preventing use of launching nose or far-bank rollers. A counterweight tail is used instead of the standard skeleton nose to keep the balance point behind the near-bank rocking rollers during launching. Bridge is launched with end posts mounted on leading end and landed directly on far-bank bearings.

c. Fixed Counterweight. A fixed counterweight is added to the end bay of the bridge or tail just before final launching to the far bank. Any available material of known weight such as spare bridge parts, sandbags, or vehicles can be used.

d. Movable Counterweight. A movable counterweight is added earlier in the bridge assembly and rolled back onto successive end bays to counterbalance progressive launching stages. The two types of rolling counterweight are—

(1) *Vehicles.* Trucks, trailers, tanks, tractors, and bulldozers mounted on the bridge deck are pushed, or moved back under own power as assembly progresses. Vehicles can be loaded to weights shown in launching tables or shifted slightly in position on the deck of the end bay to provide correct counterbalance. Backspace is often increased by requirements for ramps and space to maneuver and mount the vehicle on the deck.

(2) *Rolling platforms.* Figure 18–1 shows two movable platforms rolling on inverted plain rollers. Additional counterweight is added in the form of spare bridge parts, sandbags, or any available material of known weight. Platforms can be used singly or together with either a skeleton launching nose or launching tail. Special details in assembly and launching are as follows:

(*a*) Four plain rollers are required for all lower platforms and for all upper platforms on SS bridges. Upper platforms on double-and triple-truss bridges require eight rollers. In triple-truss assembly upper platform rollers must not bear on the outer trusses. Rollers need not be fastened to the stringer framework.

(*b*) Platforms are moved by block and tackle on both trusses.

(*c*) Horizontal bracing frames on the top bridge chord are added after the bays have passed under upper platform rollers.

e. Backspace. Table 18–1 shows the backspace required to launch panel bridges by the standard launching nose method and by both counterweight methods using either fixed or rolling counterweights. The center of gravity or balance point of the bridge is always kept at least 2 feet behind the near-bank rocking rollers. Distances in the table include 12 feet to add the last bay of bridge or tail.

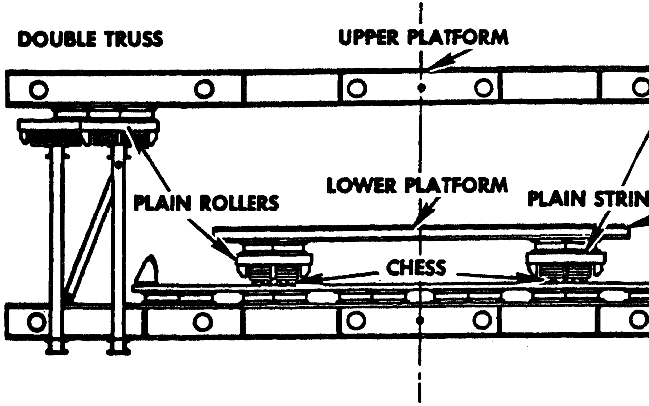


Figure 18–1. Rolling platform counter

Table 18–1. Backspace in Feet Required to Launch Fixed Panel Bridges [1]

Bridge: Type	Bridge: Span (feet)	Launching method: Standard nose — Counterweight: None [2]	Fixed [3]	Rolling [3]	Tail — Fixed [4]	Rolling [4]
SS	30	35	28	26	30	24
	40	43	31	31	35	24
	50	47	37	32	40	24
	60	55	41	36	50	33
	70	63	48	42	55	33
	80	67	53	42	60	34
	90	75	56	46	70	43
DS	50	45	36	32	41	26
	60	52	39	36	51	33
	70	57	43	36	56	33
	80	64	51	43	61	34
	90	71	54	46	66	34
	100	76	58	46	75	43
	110	83	65	51	85	53
	120	90	68	56		
	130	95	77	63		
	80	63	50	42	68	43

combined stres
launching rolle

18–2. Launchi

a. Assembly
launching nose
bays, and orga
same as in sta
However, use
bays as count
far bank requi

(1) *Roller*
rollers in pairs
singly as in the

(2) *Addi*
noses can be n
after the assem
mounting of
more space is
terweight to th

data for launching with tail and counterweight. Tails shown are of minimum allowable length to maintain chord stresses over rocking rollers within allowable limits. Where the site permits the use of longer tails, corresponding lighter coun-

terweights can
about the near
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values shown i
tons in place of

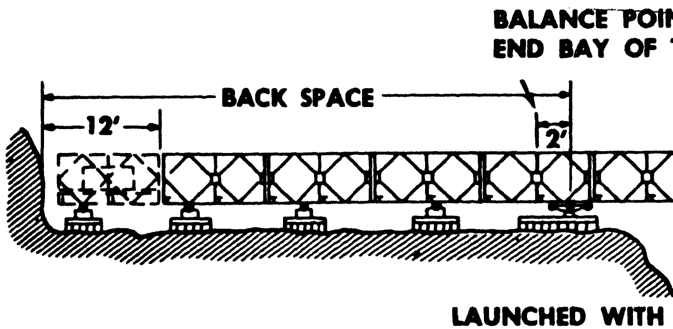


Figure 18–2. Site layout for launching with tail and c
Backspace requirements on near bank.

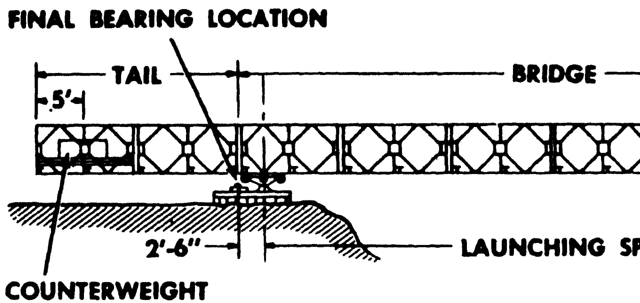


Figure 18–3. Site layout for launching with tail and counterweight. Ne

Table 18–3. Assembly for Launching With Tail and Co

Bridge [1]		Back space (feet)		
Type of construction	Span (feet)[2]	Fixed CW	Rolling CW	Length (bays)
	30	30	24	
	40	35	24	
	50	40	24	

kept to a minimum by installing only such decking on the cantilever over the gap as required to operate the davits.

18–7. Swinging

Panel bridges can be swung across diked canals by assembling complete with launching nose or tail on top and parallel to the near-shore dike and pivoting the bridge about its balance point on improvised pipe rollers.

18–8. Launching Without Rollers

Single-single bridges up to 40 feet long can be launched by manpower without rollers by skidding on greased beams. Greased timbers or greased stringers are placed at the edge of the gap and 20 feet back under each line of trusses. The bridge is assembled on the skids with one transom per bay and no stringers or chess. Three bays of tail are added with two transoms per bay and stringers in the last bay as a counterweight. The bridge is then pushed out over the gap with the aid of pinchbars and levers. Men on the far bank lift the front end onto blocking. The tail is removed, end posts are added, and the bridge is jacked down onto bearings. Second transom is added in each bay and decking and ramps are laid, completing the bridge. If end posts and bearings are not available, the ends of the bridge are supported as described in chapter 24.

18–9. Launching by Flotation

a. Advantages.

(1) Large assembly site is not needed.

(2) Assembly site can be away from center-

bridge overhar
vides clearanc
when floating
launch the spa
from the brid
typical 90-foot
follows (fig 18-

Stage 1.
pontons and
bridge above p
shore. Place la
cribbing on raf

Stage 2. P
on far-shore ra
clearance betw
position over
far-shore raft
rollers.

Stage 3. A
pontons and c
shore raft unti
of bridge. If r
close inshore, p
near-shore raft

Stage 4.
bridge, pump w
is supported
(whichever is
until span is ra
shore. If rockin
roll span into
lower chord of
span in position

Stage 5. M
piers.

Stage 6. Pr

CHAPTER 19

LAUNCHING BY SINGLE GIRD

19–1. Basic Factors

a. Use. The launching of panel bridges one girder at a time is advantageous when—

(1) Launching from an existing bridge where piers are wide enough to take the ends of a new span, but the existing bridge is not wide enough to launch the new span complete. Examples are—

(*a*) Existing through-type panel bridge (fig 19–1).

(*b*) Existing through-type civilian bridge where the width between side walls or trusses is less than 20 feet 8½ inches (fig 19–2).

(c) Existing deck type bridge where width of deck is less than 20 feet 8½ inches (fig 19–3).

(*d*) Launching span of panel bridge to a point much lower or of varying height, as to inter-

mediate landin
water (fig 19–

(2) Laun
19–5).

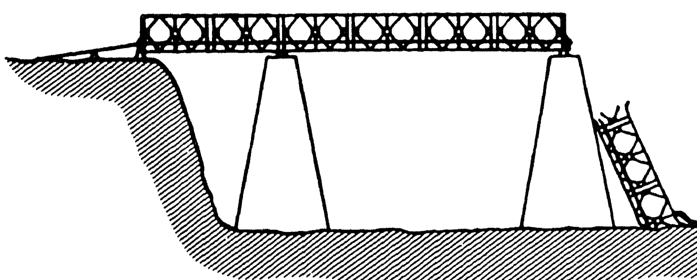
b. Types of

(1) *Descr*
up of a single
connnected to
plates. Five t
that can be
shows girders
to five trusses.

(2) *Use.*

(*a*) Sin
ders are used f

(*b*) An



deck-type panel bridge. To save launching time, the wider girders are used in preference to many narrow bridges. Four-and five-truss girders usually are used for multilane deck type bridges.

c. Assembly Sequence.

(1) A girder is assembled on the deck of the existing bridges and then launched over the gap.

(2) It is lowered or slid into position and then the next girder is launched.

(3) Standard sway braces, transoms, stringers, and decking, or expedient bracing and flooring are added to complete the bridge.

d. Methods of Launching. Single-truss girders may be launched with gin poles or high line. Multitruss girders may be launched by any one of the following methods:

(1) Counterweight.

(2) Launching nose.

(3) Gin pole and snubbing tackle.

(4) High line.

e. Working Parties. The size of working parties varies with size of girder. To assemble girders, men are divided into panel parties, pin parties, and bracing parties. They combine to launch the girders. After the girders are in place, the men are divided into bracing and flooring parties to complete the bridge.

f. Limitations.

(1) Launching by single girders takes longer than the normal method of launching panel bridges.

(2) A girder is always launched as a single-story girder. Additional trusses or stories are

the arrangeme
girder.

(2) Rock
When trusses a
rocking rollers
two outer truss
by tie plates a
under the inn
Under the the
rocking rollers
(fig 19–8).

c. Layout of

(1) Rocki
the gap and pl
foot intervals
With double-tr
used instead o
gap.

(2) When
or launching n

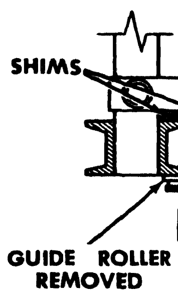


Figure 19–7. A
triple truss (2
moved. Shims
channel flange
down.

bled and launched on the side of the existing bridge nearest its final position. A second girder is assembled simultaneously at the other side of the deck of the existing bridge. Rollers are laid out accordingly.

(3) When using a gin pole and snubbing tackle, two gin poles, or a high line, rollers are laid out so the girder is assembled and launched

along the centerline of

(4) When launchi
bridge, all plain roller
transoms to avoid ov
19–9). Rocking rollers
bing directly on the p
place the rocking roller

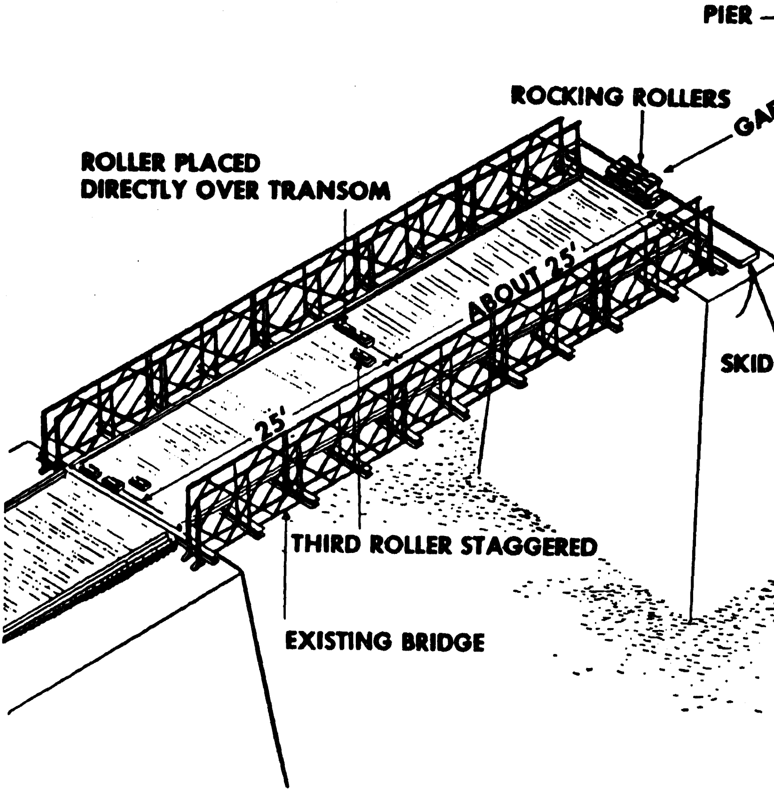
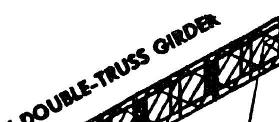


Figure 19–9. Layout of launching rollers for launching triple-truss (3'–0") girder fro



ing panel bridge, they are placed directly over the end transom. If the total launching weight on the rocking rollers is greater than 14 tons, two transoms are used under the rollers; if the launching weight is greater than 28 tons, cribbing is wedged under the center of the end transoms.

19–3. Assembling Girders

a. The girder may be made up of from two to five trusses (fig 13–29).

b. Trusses of multitruss girders are connected at every possible place by bracing frames and tie plates across the top chords and ends of panels. All tie-plate bolts must be tight and shims must be used to prevent the outer truss from slipping down when the end of the girder is over the gap (fig 19–7). In girders with the outer trusses spaced 8½ inches, the panel pins connecting the nose to the main girder are inserted from the inside so the nose can be disconnected after launching. In all other cases in both the main girder and the nose, the pins are inserted from the outside toward the centerline of the girder.

c. End posts are placed on the front end of all trusses before launching, except when a launching nose is used, in which case the front end posts are placed after the girder has been launched. Rear end posts are placed when the girder is in position for jacking down.

Table 19–1. Parts Required to Assemble Single and Multitruss Girders

Item	Number of parts per two bays							
Number of trusses	One	Two	Three	Three	Four	Four	Four	Five
Spacing of outer trusses		1′-6″	2′-2½″	3′-0″	2′-2½″	2′-11″	4′-6″	4′-5″
Bolt, bracing	----------	[2] 16	24	24	[4] 32	36	[2] 36	48
Frame, bracing	----------	[2] 4	[3] 3	6	[4] 4	[3] 3	[2] 9	6
Panel	2	4	6	6	8	8	8	10
Pin, panel [1]	4	8	12	12	16	16	16	20
Plate, tie	----------	----------	6	----------	8	12	----------	12
Post, end	Add one end post at each end of each truss.							

[1] Add two panel pins at end of each truss.
[2] Add one bracing frame and four bracing bolts in last bay.
[3] Add ono bracing frame in last bay.
[4] Delete one bracing frame and four bracing bolts from last bay.

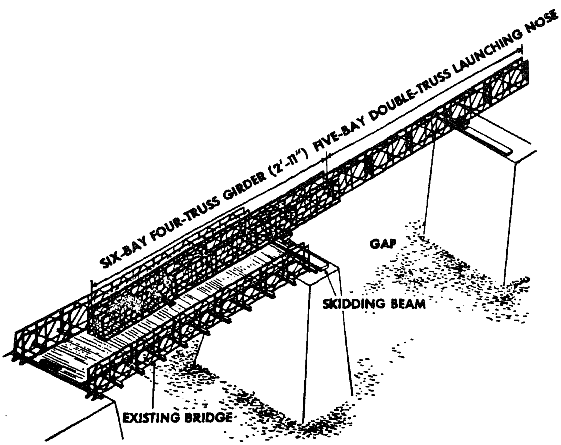


Figure 19–11. Launching four-truss girder with launching nose. See table 19–3 for the length of nose needed with various

19–4. Launching Girder

a. Counterweight Method (fig 19–10)

(1) A counterweight is added to the rear end of the girder to balance the front end of the girder as it is pushed on rollers out over the gap. Long girders may be kept in line by using side guys and a pull winch from the far pier. When across the gap, the front end lands on rollers at the far bank or pier, or on the landing-bay pier of a floating bridge. The counterweight is then disconnected, rear end posts are attached, rollers at each end are removed, and the girder jacked down onto a skidding beam.

(2) Girders may be counterweighted either by adding weights to the last bay of a short tail on the girder or by making the girder of the same assembly and twice as long as the span so the tail alone will counterbalance the span. Table 19–2 lists weights needed on short tails to counterweight various spans of multitruss girders. If the long tail is used, it may be disconnected after the first girder is launched, and used for a second girder.

Table 19–2. Required Counterweight for Various Spans of Multitruss Girders[1]

Span (feet)[1]	Number of bays in tail	Counterweight (tons)[2]	Total weight on rocking rollers (tons)
Double-truss girder and tail			
40	3	1.1	5.6
50	3	2.3	7.5
60	4	2.0	8.6
70	4	3.5	10.4
80	5	3.0	11.4
90	5	4.2	13.3
Triple-truss girder and tail with outer trusses spaced 2′2½″			
40	3	1.6	8.3
50	3	3.3	10.9
60	4	2.9	12.4
70	4	4.8	15.1
80 [3]	5	4.4	16.5 [3]
90 [3]	5	6.2	19.3 [3]
Triple-truss girder and tail with outer trusses spaced 3′0″			
40	3	1.7	8.5
50	3	3.5	11.3
60	4	3.0	12.7
70	4	4.9	15.6
80	5	4.4	17.0
90	5	6.3	19.9
Four-truss girder and tail with outer trusses spaced 2′2½″			
40	3	2.1	11.0
50	3	4.5	14.7
60	4	3.9	16.5
70	4	6.4	20.3
80	5	5.9	22.2
90	5	8.2	25.8
Four-truss girder and tail with outer trusses spaced 2′11″			
40	3	2.1	11.0
50	3	4.4	14.4
60	4	4.0	16.5
70	4	6.3	20.1
80	5	5.8	22.0
90	5	8.2	25.7
Four-truss girder and tail with outer trusses spaced 4′6″			
40	3	2.2	11.4
50	3	4.6	15.1
60	4	4.1	17.2
70	4	6.6	21.0
80	5	6.1	23.0
90	5	8.5	26.7
Five-truss girder and tail			
40	3	2.7	13.9
50	3	5.6	18.4
60	4	5.0	20.8
70	4	8.0	25.5
80	5	7.4	28.0
90	5	10.3	32.4

See notes below table.

[1] Longer spans cannot be launched by this method because of insufficient lateral stability.
[2] Counterweight added to last bay of tail.
[3] Use plain rollers for launching. Place one roller under each truss.

(3) The counterweight method is useful when site conditions at the far side prevent use, removal, or disposal of a launching nose, or erection of a gin pole or high line. When launching long girders of a deck type bridge, a counterweight permits tipping the far end directly onto the pier without jacking down.

b. Launching-Nose Method (fig 19–11)

(1) A lightweight launching nose is attached to the front end of the girder, and the girder with nose is pushed on rollers out over the gap. To compensate for sag, launching-nose links may be used in the same manner as when launching the normal panel bridge. Long girders may be kept in

line by using side guys and a pull winch. When across the gap, the nose lands on rollers on the far bank. It is then disconnected, front end posts are attached, rollers at each end are removed, and the girder is jacked down onto skidding beams.

(2) Table 19–3 lists the types and lengths of noses needed to launch multitruss girders. Single-truss girders cannot be launched by this method. Launching noses are braced the same as the girder. When launching the triple-truss girder with an eccentric double-truss nose, the nose must be dismantled bay by bay as it passes over the landing rollers. Otherwise, the nose beyond the landing rollers twists the girder, and may cause failure.

(3) The launching-nose method is used for longer girders, where sag is appreciable. It can also be used for girders too heavy for a gin pole or high line. Launching by this method is easier than with a counterweight, because the girder with nose is lighter than the girder with counterweight.

c. Gin-Pole and Snubbing Tackle Method (fig 19–12)

(1) A gin pole is erected at the far bank or pier. Tackle is rigged from the gin pole to the front end of the girder with the fall line running to the winch of a truck on the bridge or bank. When a truck-mounted crane or a tractor is used at the tail of the girder, the fall line is led around it by a snatch block at the side of the bridge. For long, heavy girders, guy lines are attached near the center of the girder on each side and controlled by winches on trucks to each side of the bridge. The girder rides on rollers on the near bank. It is braked by snubbing tackle attached to the rear end of the girder. When a truck-mounted crane is used at the rear of the girder, the hoist line is attached to the top of the rear end of the girder to keep it upright and to lift it onto the bearings. Power applied to the hauling winch pulls the girder across the gap. The truck-mounted crane moves forward with the girder, keeping the snubbing line taut to prevent too rapid movement. When the girder has passed its balance point, it is allowed to dip about one-tenth of its length to lessen stress in the tackle. After the girder is across the gap, the gin pole and the truck-mounted crane lift it directly onto the bearings.

(2) When a truck-mounted crane is not available, two gin poles may be used, one on each bank. Both gin-pole lines are attached to the front end of the girder, which is pulled over the gap by taking up on the far gin-pole line and slacking off on the near gin-pole line. When the front end of the girder is over the far bank, the line from the near gin pole is changed from the front to the rear end of the girder, which is then lowered onto its bearings.

(3) This method is better for short spans, since long girders are heavy and difficult to handle. It also saves bridge equipment, because it eliminates the need for either a launching nose or counterweight. In addition to handling girders, the gin pole and truck-mounted crane can be used to "telegraph" transoms and decking into place (para 19–7*a*(2)).

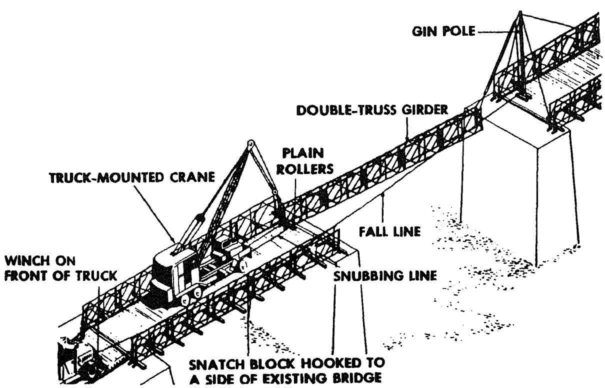


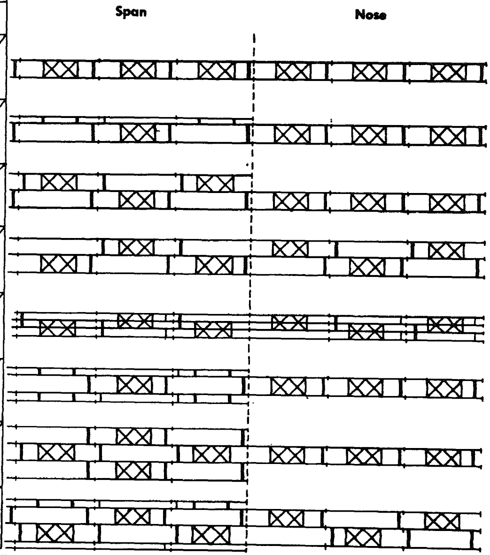
Figure 19–12. Launching a double-truss girder with gin pole and snubbing tackle.

Table 19–3. Composition of Launching Noses and Launching Weights of Multitruss Girders

Number of bays in nose (No) / Launching weight in tons (Wt)

Type of girder	Spacing of outer trusses	Type of nose	Span (feet)[1] 40	50	60	70	80	90	100	110
Double-truss	1'-6"	Double-truss	4 / 5.0	5 / 6.4	6 / 7.6	7 / 8.8	8 / 10.2	9 / 11.4		
Triple-truss	2'-2½"	Double-truss[2]	4 / 6.2	5 / 7.8	6 / 9.3	6 / 10.3	7 / 11.8	8 / 13.4		
Triple-truss	3'-0"	Double-truss[2]	4 / 6.3	5 / 8.0	5 / 8.9	6 / 10.5	7 / 12.0	8 / 13.7		
Triple-truss	3'-0"	Triple-truss	4 / 7.6	5 / 9.6	6 / 11.4	7 / 13.4	8 / 15.2	9 / 17.2		
Four-truss	2'-2½"	Four-truss	4 / 9.9	5 / 12.4	6 / 14.8	7 / 17.3	8 / 19.8	9 / 22.3	10 / 24.8	
Four-truss	2'-11"	Double-truss	3 / 6.8	4 / 8.6	5 / 10.6	6 / 12.4	6 / 13.6	7 / 15.5	8 / 17.4	9 / 19.2
Four-truss	4'-6"	Double-truss	3 / 7.0	4 / 8.9	5 / 10.9	6 / 12.8	6 / 14.1	7 / 15.9	8 / 17.9	9 / 19.8
Five-truss	4'-5"	Triple-truss	4 / 10.0	4 / 11.6	5 / 14.1	6 / 16.6	7 / 19.2	8 / 21.6	8 / 23.2	9 / 25.7

PLAN VIEW



[1] Longer spans cannot be launched by this method because of insufficient lateral stability.
[2] Remove nose as each bay clears far-shore landing rollers.

KEY

- Panel
- Bracing frame on top of panels
- Bracing frame on end of panels
- Tie plate on top of panels
- Tie plate on end of panels

d. Direct-Lift Method.

(1) The girder is assembled on the ground beside the piers. Two cranes or gin poles lift the girder into place on the piers. In case of a water gap, the girder may be floated out to the piers and lifted into place by cranes on rafts or on the piers. Cranes are not needed if the piers are low enough so the girder can be floated into place and lowered onto the piers by pumping water into the raft pontons.

(2) The length of girder that can be launched by this method is limited by the capacity of the cranes. If the girders are short and light, a single crane can be used.

e. High-Line Method (fig 19–13)

(1) A high line of suitable capacity is rigged across the gap along the centerline of the bridge. The girder is suspended from the high line, pulled over the gap, and lowered onto skidding beams. The trolleys on the high line are attached to slings on the girder near the quarter points. The girder is rolled on the approach span to its balance point on the first roller before being carried by the high line. Tag lines at both ends of the girder are used to control it during launching.

(2) This method is useful for launching deck type bridges where the girder has to be lowered a considerable distance to the skidding beams. In addition to handling the girders, the high line can be used to carry out the transoms and decking; and where trestle approach spans are used, it can be used to carry out bridge parts for the approach spans. This method also eliminates the need for either a launching nose or counterweight. The capacity of high lines is usually limited to short single or double-truss girders. Table 19–4 lists the weights of various lengths of girders.

Table 19–4. Weight of Single-Truss and Multitruss Girders

Span (feet)	Number of trusses / Spacing of outer trusses	Weight (tons)							
	Number of trusses	One	Two	Three	Three	Four	Four	Four	Five
	Spacing of outer trusses	—	1′6″	2′2½″	3′0″	2′2½″	2′11″	4′6″	4′5″
30		0.9	1.9	2.8	2.8	3.7	3.7	3.8	4.7
40		1.2	2.5	3.7	3.8	4.9	4.9	5.1	6.2
50		1.5	3.2	4.6	4.8	6.2	6.1	6.4	7.8
60		1.8	3.8	5.5	5.7	7.4	7.4	7.7	9.3
70		2.1	4.4	6.5	6.7	8.7	8.6	9.0	10.9
80		2.4	5.1	7.4	7.6	9.9	9.8	10.3	12.5
90		2.6	5.7	8.3	8.6	11.1	11.1	11.5	14.0
100		2.9	6.4	9.3	9.5	12.4	12.3	12.8	15.6
110		3.2	7.0	10.2	10.5	13.6	13.5	14.1	17.1
120		3.5	7.6	11.1	11.4	14.8	14.7	15.4	18.7

Note Without end posts.

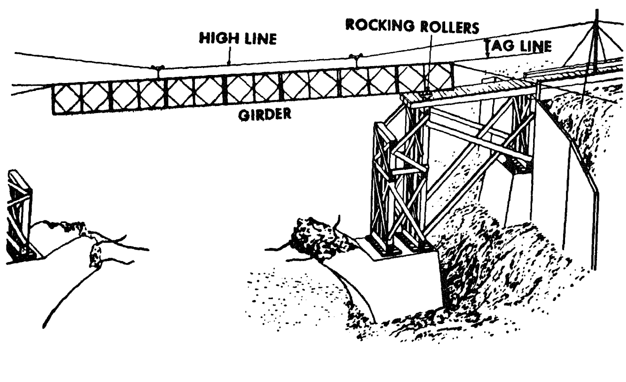


Figure 19–13. Launching single-truss girder with a high line.

19–5. Jacking Down

The girders are jacked down either with a jack under each end post or with jacks under an equalizing beam supporting the underside of the girder (fig 19–14). The jacks should be operated in unison so the girder is lowered evenly. During the lowering, the girders should be guyed to prevent overturning. To lower the girder in its final stage, place equalizer beam under top chord as in figure 16–19. Place cribbing under the bottom chords or equalizer beam to prevent the girder from dropping if it slips off the jacks. If the distance to be lowered is great, the girder is lowered by successive stages. When truck-mounted cranes or gin poles are available at each end of the bridge, the girders are lowered directly on the bearings.

19–6. Skidding Girder Into Position and Squaring Up

a. After launching, the girder is moved into position by truck cranes, or skidded into position on greased skidding beams by prying with panel levers or pinchbars (fig 19–15). Panel-bridge stringers are preferred for skidding beams, but I-beams or timber beams may be used.

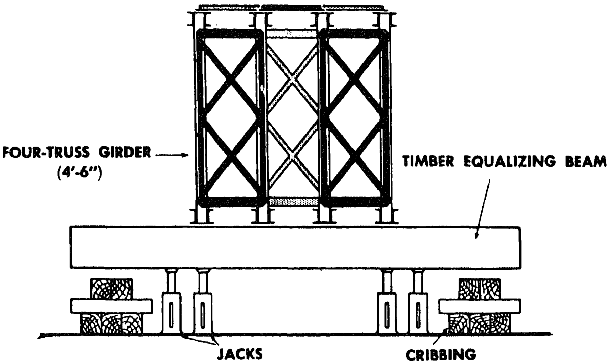


Figure 19–14. Jacks under four-truss girder using equalizing beam.

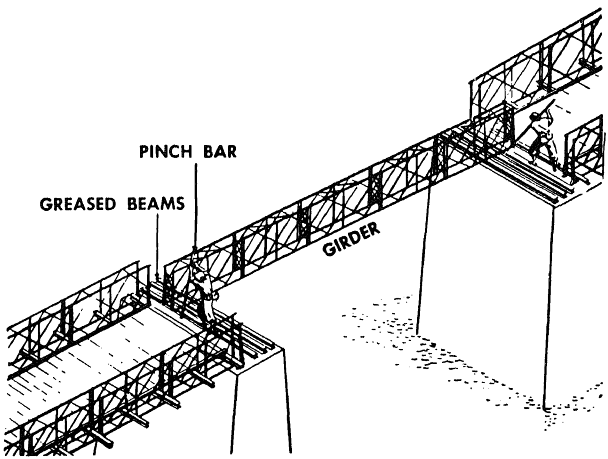


Figure 19–15. Skidding girder into place by prying with pinchbars.

b. After the first girder is lined up with the existing bridge, the second girder is squared up with the first. If the trusses cannot be moved in a longitudinal direction without rollers, rollers are reinserted after skidding.

19–7. Completing Bridge

a. Normal Through-Type Assembly. The bridge is completed bay-by-bay working out from the near shore in the following sequence:

(1) Insert sway braces of first bay with adjusting collars on the same side of bridge. Two lashings from centers of bottom brace are used to hold center of sway braces up until ends have been pinned in place. Do not tighten.

(2) Place transoms in first bay. A truck-mounted crane with gin pole on far bank may be used to "telegraph" transoms into place, or they may be placed by hand. In the "telegraph" method a line from the gin pole on the far bank and a line from the crane on the near bank are both attached to the transom. The transom is then picked up and placed by taking up the gin-pole line and slacking off on the crane line. A tag line on the transom is used to guide it. When handled manually, the transom is pushed out from the bank and swung into position with the aid of ropes attached to the top chords. The transoms are difficult to fit at first, but this becomes easier as more bays are completed.

(3) Place stringers in first bay.

(4) Remove vertical bracing frames and insert rakers. Do not tighten.

(5) Repeat above procedure to install sway braces, transoms, stringers, and rakers in second bay.

(6) After bracing members are inserted in second bay, tighten all bracing in first bay and lay chess and ribands in first bay.

(7) Remainder of decking is added in the same manner.

(8) Install ramps.

b. Deck-Type Bridges. These are decked either with standard panel-bridge flooring or with expedient timber decking. For details of deck-type bridges, see chapters 12 and 13.

CHAPTER 20

BRIDGES ON BARGES

Section I. PLANNING

20–1. Introduction

The panel bridge on barges consists of a standard panel bridge supported on floating piers made from river or coastal barges of suitable type and capacity. Special spans or parts are used to provide hinged joints between floating bays (fig 20–1 and 20–2).

20–2. Piers

Piers consist of barges or vessels suitably prepared to support the panel-bridge superstructure.

a. Floating-Bay Piers. Floating-bay piers support the floating bays in the interior of the bridge.

b. Landing-Bay Piers. Landing-bay piers support the shore end of the floating bay and the riverward end of either the fixed-slope landing bay or the variable-slope landing bay.

c. Intermediate Landing-Bay Piers. Intermediate landing-bay piers support the shore end of the fixed-slope landing bay and the riverward end of the variable-slope landing bay. The intermediate landing-bay pier is not used without the fixed-slope landing bay.

20–3. Bays

The span between two articulating points sup-

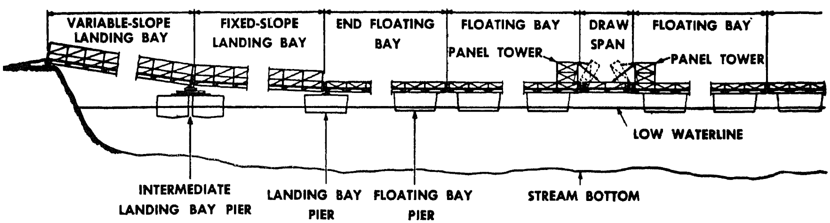


Figure 20–1. Nomenclature of panel bridge on barges. Steep bank (no ground piers).

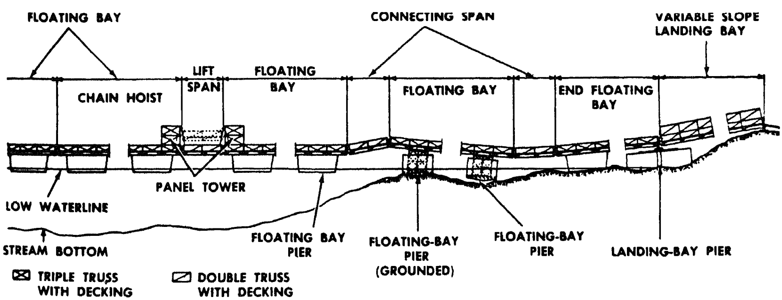


Figure 20–2. Nomenclature of panel bridge on barges. Gradual sloping bank (with grounded piers).

ported by two floating piers or between the shore and a floating pier is called a bay (fig 20–3).

a. Floating Bays. Floating bays are the interior bays of the bridge from the end floating bay on the near shore to the end floating bay on the far shore. They are supported near each end by floating-bay piers.

b. End Floating Bays. End floating bays form the continuation of the bridge between the floating bays and the landing bays. They are supported by a landing-bay pier and a floating-bay pier.

c. Landing Bays. Landing bays form the connection between the end floating bay and the bank. There are two types of landing bays—

(1) *Variable-slope landing bay.* The variable-slope landing bay spans the gap between the bankseat and the landing-bay pier or the intermediate landing-bay pier if a fixed slope landing bay is used.

(2) *Fixed-slope landing bay.* The fixed-slope landing bay spans the gap between the intermediate landing-bay pier and the landing-bay pier.

20–4. Special Spans

a. Connecting Span. A connecting span connects two adjacent floating bays where barges are grounded. It provides two articulating points to compensate for the changes in slope between the floating bays (para 20–6*b*(1)).

b. Lift Span. A lift span (fig 20–4) connects two adjacent floating bays. The span can be lifted vertically by use of block and tackle or chain hoists to allow passage of water traffic through the bridge (para 20–6*b*(2)).

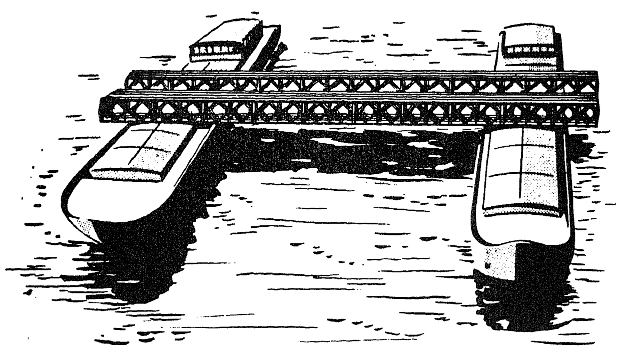


Figure 20–3. Floating bays.

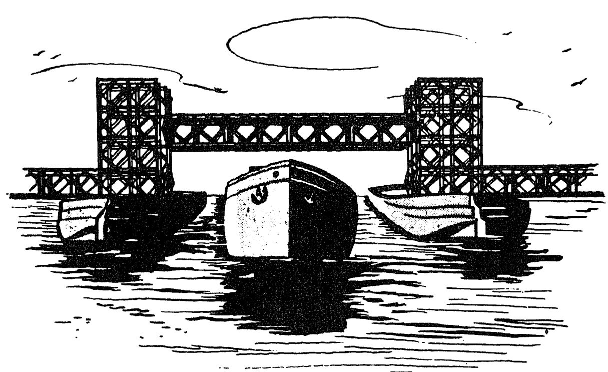


Figure 20–4. Panel-bridge lift span.

c. *Draw Span.* A wider gap between adjacent floating bays for passage of river traffic can be obtained by use of a draw span. The draw span can be split in the middle and each half pivoted up (para 20–6*b*(3)).

20–5. Design and Capacities of Barges

a. Description. Coastal and river barges differ widely in construction and capacity throughout the world. In Europe and the Americas, barges are generally flatbottomed. Barges with round or semiround keels are also found on European canals and rivers (fig 20–5). Asiatic barges have less capacity than European or American barges.

b. Capacity. Generally, European and American barges have a capacity of from 80 to 600 tons. The general condition and soundness of the barge has a direct effect on its use in a bridge.

(1) *Ribs.* Structural ribs of barges are designed for bending stresses induced by water pressure on the outside of the hull. They are normally bulb-angled steel sections 5½ to 7 inches deep, closely spaced, and curved rather than straight. Ribs should not be loaded as struts unless they are braced and load is distributed. To distribute the load, timber cribbing can be used along the gunwale directly over the ribs. If the rib is not curved and the length of rib from deck to keel does not exceed 10 feet, each rib will support approximately 5 tons.

(2) *Floor.* Barge floors are designed for distributed loads. A wide variation of floor design exists and care must be taken in estimating their capacity. European flat-bottomed barges normally use transverse beams of Z section 6 to 7 inches deep, carrying light channels or I-beams fore and aft to support a timber floor. A floor of this type can carry a bearing pressure of 0.5 ton per square foot.

20–6. Design of Superstructure

a. Normal Assembly. Superstructures of normal bays consist of DS, TS, DD, or TD assembly of standard panel-bridge equipment. Normally, floating-bay superstructure is single-story assembly and landing-bay superstructure double-story assembly.

(1) *Decking.* Decking for superstructure consists of standard chess with 3-inch wear treads laid diagonally over the chess. Angle irons are added to the deck on the landing bay to increase traction. When connecting posts are used to connect floating bays, transoms and junction chess cannot be used to fill the gap between bays. Cut stringers are placed on the two transoms at the end of each bay, and two thicknesses of 3- by 12-inch planks spiked together are placed on top of the cut stringers (fig 20–6). Planks are wired in place to prevent shifting. When span junction posts are used to connect bays, the gap between bays is filled in the normal manner, using transoms and junction chess. Where maximum road width is desired, ribands can be eliminated by a 2- by 24-inch hub guard installed 6 inches above the deck to protect the panels.

(2) *Connections.* Special connecting posts are used to connect the bays together and provide articulation (fig 20–7). These special connecting

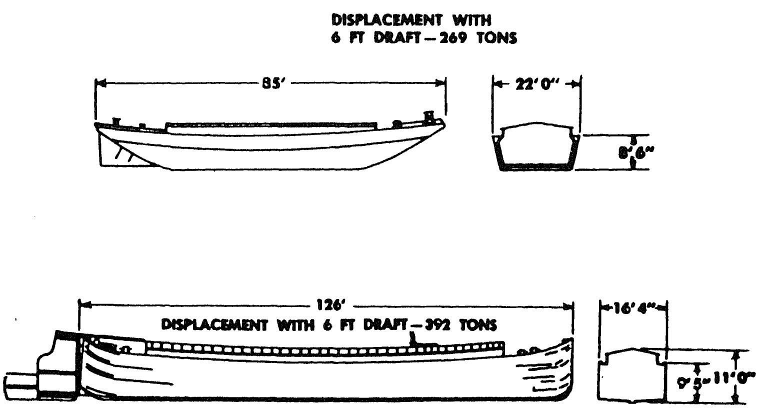


Figure 20–5. Typical European barges.

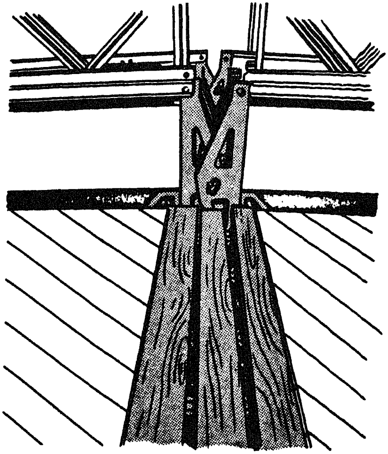


Figure 20-6. Planks on cut stringers for filling gap between bays when bays are connected with special connecting posts. Note hub guards and special connecting posts.

posts provide ample strength and allow development of full capacity of superstructure. Equal articulation above and below the connecting pin provides unrestricted space for movement in the connection. Such connectors do not require restrictive linkages, guides, or maintenance. Combination special connecting posts can be used in place of the normal posts and in addition can be used to connect two male ends of panels or two female ends of panels.

b. Special Assembly. Special spans are used when barges are grounded or when passage of water traffic through the bridge is necessary. The capacities of the special spans are the same as the normal spans. However, their full capacity cannot be developed unless the suspending connection at each end is made strong enough. In addition, the weight of the lift span and draw span is limited by the lifting power and strength of the hoists, thus affecting the type of construction that can be used in these spans. The three types of special spans used are connecting spans, lift spans, and draw spans.

(1) *Connecting span.* The connecting span is used when barges are grounded or when special connecting posts are not used. It consists of a short span of SS or DS assembly suspended between two floating bays by span junction posts (fig 20–8).

(2) *Lift span.* Lift spans can be used only in short bridges where the current is slow and there are no longitudinal forces in the bridge. When the current is swift, the pier heights can be increased to arch the bridge enough to pass water traffic under one of the center spans without the use of a lift span. The lift span is SS or DS assembly 20 or 30 feet long. It is raised horizontally by block and tackle attached to the span and to panel towers in the adjacent bays.

(3) *Draw span.* The use and the restrictions of the draw span are the same as for the lift span. The draw span is SS or DS assembly usually 20 feet long (fig 20–9). It is hinged and suspended to adjacent bays by span junction posts. It is raised at one end by block and tackle attached to the span and a panel tower in one of the adjacent bays. If the resulting gap is insufficient, a span of 40 feet can be used and a cut made at the center of the span. Towers with block and tackle are then used at both ends and each half lifted separately.

20–7. Design of Bays

The barges and the superstructure together form sections called bays.

a. Floating Bays. Floating bays are normally double-single assembly. However, for loads of 100 tons or more, unsupported span lengths are limited to 60 feet and assembly must be triple-single. The class is limited by the type of assembly, the span between centers of barges, and the method used to support the superstructure on the barges. The class of floating bays is given in table 20–1. Normally, a barge near each end of a bay supports the superstructure. The superstructure must not overhang the barge at each end more than 15 feet from the centerline of the barge. However, a single barge can be used if it has ample width and capacity and the bay is stable under the load.

b. Landing Bays. The type of assembly used in landing bays depends on length of span and loads to be carried. Triple-double assembly is the heaviest used. Maximum slope of the bay is 10 to 1 with adequate traction devices provided; without traction devices, slope is 21 to 1. Length of landing bay depends on conditions near shore. Double landing bays are used where considerable change in water level is expected or when high banks are encountered. Landing bays are assembled the same as normal panel bridges and use the same type of end support.

20–8. Personnel Required

The assembly of large bridges on barges should

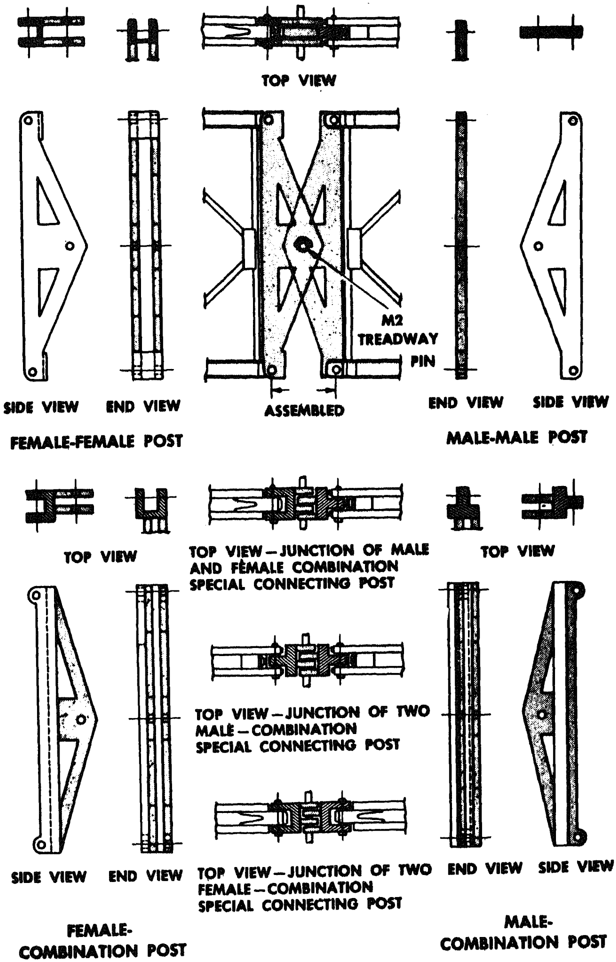


Figure 20–7. Special connecting posts.

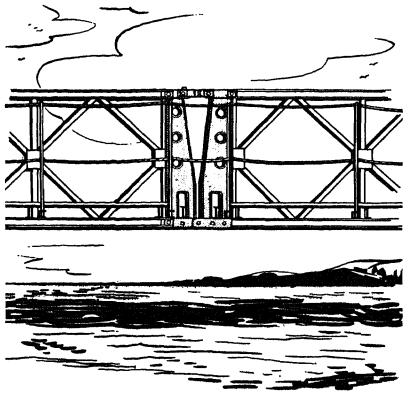


Figure 20–8. Use of span junction posts to suspend connecting span between bridge bays.

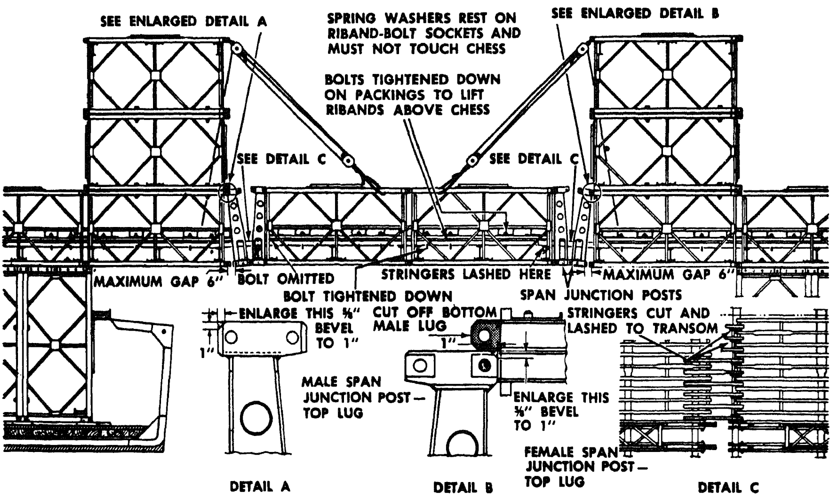
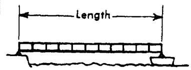
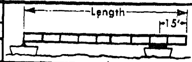
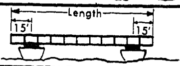
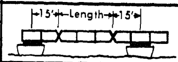
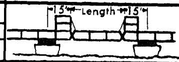
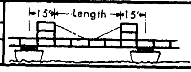


Figure 20–9. Panel-bridge draw span.

Table 20–1. Class of Bays and Spans in Panel Bridge on Barges

Type of bay or span	Truss construction	Length of bay or span (feet)														Illustration
		20	30	40	50	60	70	80	90	100	110	120	130	140	150	
Landing bay	SS		40	32	28	26	22	18	13	10						
	DS		107	93	80	67	64	51	44	31	23	18	13	10		
	TS				113	100	88	80	62	52	40	34	23	18	13	
	DD							103	90	75	64	50	40	31	23	
	TD								106	93	80	70	57	48	40	
	DT										106	93	80	67	65	
	TT													105	93	
End floating bay	SS				36	30	26	22	18	15	11					
	DS				100	86	73	62	52	44	35	27	20	15	11	
	TS						106	94	81	68	56	45	35	27	20	
Floating bay	SS					40	32	28	24	20	17	13	10			
	DS					107	93	80	67	57	48	40	31	23	18	
	TS							113	100	88	75	62	50	40	31	
Connecting span	SS	28	24													
	DS	80	67													
	TS	113	100													
Lift span	SS	28	24													
	DS	80	67													
	TS	113	100													
Draw span	SS	28	24	20												
	DS	80	67	57												
	TS	113	100	88												

be assigned to at least an engineer construction group or an engineer combat group. Paragraph 20–15 gives details of working-party organization.

20–9. Advantages and Disadvantages

a. Advantages. The panel bridge on barges has the following advantages:

(1) It does not use standard floats and pontons which may be needed at other sites.

(2) It allows long landing floating bays for use in tidal estuaries or rivers with high banks.

(3) It has large capacity barges which allow greater bridge capacity than standard military floating supports.

(4) It provides a stable bridge in swift currents.

(5) It minimizes hazards of floating debris and ice.

b. Disadvantages. The bridge has the following disadvantages:

(1) It uses barges which may be difficult to obtain.

(2) It can be used only in navigable streams or waterways used by barges or vessels of the type and size necessary for use in the piers.

(3) It is not adaptable in combat areas because of equipment, material, labor, and time requirements.

Section II. EQUIPMENT

20–10. Barges

a. Processing. Barges are procured locally and should be processed as follows:

(1) Examine and rate for capacity.

(2) Determine the most advantageous point for use in the bridge.

(3) Establish the type of barge loading (para 20–17 to 20–22) to be used and sketch necessary construction to bring bearings to exact elevation established for superstructure bearings.

b. Supports on Barges. After the type of barge loading has been determined, a material estimate and equipment requirement list should be prepared for each barge. Normally, steel beams, timber, blocking, wire rope, and miscellaneous bolts

and fittings will be required. See chapter 17 for equipment required if panel crib piers are used as supports on the barges.

20–11. Superstructure

Normal spans use fixed-span panel bridge parts (chap 2). Connections between spans are made with special connecting posts that must be fabricated in the field (fig 20–7) or by connecting spans using span junction posts supplied in the panel crib pier set (chap 17).

b. Special Spans. Special spans use fixed panel-bridge parts (chap 2) plus the additional parts noted below.

(1) *Lift span.* Special fittings to guide the lift span during raising and lowering must be made in the field. Block and tackle required are supplied in the fixed-panel-bridge set. Counterweights to aid in raising and lowering the span can be improvised. The lift span and the floating bays are connected by span junction draw span during raising and lowering must be made in the field. Block and tackle required are supplied in the fixed-panel-bridge set. Counterweights to aid in raising and lowering the span can be improvised. The draw span and the floating bays are connected by span junction posts from the panel-crib-pier set (chap 17).

c. Erection Equipment. The normal erection equipment supplied in the fixed-panel-bridge set (chap 2) is sufficient to assembly the superstructure. Truck cranes aid the erection of the superstructure and the preparation of the barges. Acetylene torches, arc welders, chain falls, power and hand winches, diving equipment, and sea mules or power tugs with enough power to move floating bays into position should be available at the site.

Section III. SELECTION AND PREPARATION OF SITE

20–12. Site Characteristics

Tactical requirements determine the general area within which a site must be selected. The following factors should be carefully considered in choosing the actual site:

a. Road Net. There should be a road net close to the site over which equipment can be moved. Roads and approaches should require as little preparation and construction as possible and should be staight and level for at least 150 feet before reaching the stream bank.

b. Near-Shore Area. Near-shore area should afford suitable sites along the shore for barge preparation and bay assembly.

c. Banks. Banks should be reasonably steep and firm so that water gap will not change materially with water level. Banks high enough to allow launching of superstructure to barge piers are desirable.

d. Stream. The site should be on a straight reach of the stream or estuary and free from cross currents that would exert a longitudinal force on the bridge. Water at bridge site should be deep enough to float barges at low water if no barges are to be grounded. Water at assembly sites should be deep enough to allow preparation of barges close to shore and launching of superstructure directly to barges. If barges can be grounded at low water, the stream bottom should be reasonably smooth and level. The stream should be free of obstruction at the assembly sites and bridge site.

20–13. Reconnaissance

a. Possible Sites. The general area having been determined by tactical requirements, a study of terrain and aerial maps is made to determine possible bridge sites along the stream within the specified area.

b. Air. Direct serial reconnaissance generally obtains the following information on these bridge sites:

(1) Site relation to existing road net with estimate of road construction required.

(2) Alinement of river at site and channel obstructions in the vicinity.

(3) An approximation of height of banks to determine suitability for approaches and landing bays.

(4) Approximate width, shore-to-shore, of river and length of bridge required.

(5) Location, relative to bridge site, of material storage, equipment, and work areas, and barge site adjacent to near shore for floating-bay assembly.

(6) Location of barges large enough to be examined later in detail by ground reconnaissance.

(7) Nature of open water route from barges

to bridge site, noting and locating obstructions to navigation.

(8) Routes over existing road nets for transportation of bridge materials from dump or other sources to bridge site.

(9) Location of adjacent quarries and aggregate supplies.

c. Ground. Ground reconnaissance obtains the following data:

(1) Width of river from bank to bank.

(2) Profile of approaches and streambed.

(3) Character of soil in approaches, banks, and streambed.

(4) Profiles of possible routes of approach and linking roads to existing road nets.

(5) Current velocity.

(6) High and low water datum indicated on profile and rate of flood and ebb of tide, if possible.

(7) Sketch showing location and description of suitable material storage and work areas, downstream assembly area with profiles at possible shore barge preparation sites, and floating-span erection sites.

(8) Sketch of barges located in aerial reconnaissance.

(9) Routing on open water from assembly sites to bridge site with description and location of obstacles and estimate of work necessary to clear passage.

(10) Information on location, quality, and quantity of nearest aggregate source.

20–14. Layout and Preparation of Site

Before actual construction, alinement and grade of roads and approaches must be determined. Storage and assembly areas are planned and located in such a manner as to insure an uninterrupted progression of the work and to avoid unnecessary handling. After the location and layout of the site have been determined, road work and approaches should be completed to expedite delivery of bridge material. At the same time, landing-bay and floating-bay assembly areas are prepared. For more detailed information, see chapter 6.

Section IV. WORKING PARTIES

20–15. Distribution of Personnel

An engineer group consisting of three battalions, two panel bridge companies, one light equipment company, and one harbor craft company should be assigned to construct bridges of 500 feet or more. For shorter bridges, reductions in personnel can be made. The following table presents a suggested breakdown of jobs and troops required for constructing an 810-foot class 70 bridge in a moderate current. Approach road construction will require 5 company-days.

Jobs	*Personnel*
Abutment preparation	1 platoon
Landing-bay assembly	1 platoon
Floating-bay assembly	1 platoon
Movement and connection of bays	3 platoons (per bank)
Unloading of equipment	2 platoons (per site)
Anchorage preparation	1 platoon

20–16. Example Distribution

Assume bridge will consist of the following bays, proceeding from near to far bank: 100-foot DD variable slope landing bay; 100-foot DD fixed-slope landing bay; 80-foot TS end floating bay; An engineer group consisting of three battalions, two panel bridge companies, one light equipment 40-foot DS draw span; three 100-foot TS floating bays; 90-foot TS end floating bay; and 100-foot DD landing bay. A possible assignment of units to construct this bridge is as follows: one battalion to assemble two near-bank landing bays, 80-foot end floating bays, and one floating bay; the second battalion to assemble far-bank landing bay, 90-foot end floating bay, 40-foot draw span, and two floating bays; the third battalion to prepare approach roads, unload equipment, and prepare anchorages; the panel companies to haul bridge equipment; the harbor craft company to assist in maneuvering barges and bays; and the light equipment company to supply construction equipment with operators. Time required for completion is approximately 6 days of daylight construction.

Section V. CONSTRUCTION OF BRIDGE

20–17. Barges

a. Selection. Care must be taken in selection of barges. Structural condition, capacity, shape, freeboard, type, and location of barge must all be considered.

b. Preliminary Work.

(1) Barges located on the reconnaissance should be examined and rated. Barges which meet the requirements should be assigned a position in the bridge. Working sketches and a plan of preparation for each barge are necessary to adapt it for use as a floating pier.

(2) Nonusable, easily unloaded material should be cleared from the selected barges to facilitate towing to barge preparation sites.

20–18. Methods of Loading

Barges are adapted for use as piers by three methods. The method employed depends on the type of barge—flat-bottomed or keeled—and grounding conditions. The three methods of loading are gunwale loading, crib loading, and grillage loading.

a. Gunwale Loading.

(1) *Application* Few barges are designed for gunwale loading and it is necessary to determine the strength of the barge ribs before this method is used. Barges are normally built with a narrow deck running full length along each side of the hold. This deck space can be used for gunwale loading if the ribs and the deck are strong enough and the load is applied as nearly as possible over the ribs. Gunwale loading must not be applied to barges that will ground at low water unless the barge and the bay will remain level. If keel type barges are used, the site of grounding should be in soft mud. Flat-bottomed barges should ground on flat sandy bed free from obstructions.

(2) *Methods of adaption.* Packing must be used between the gunwale and the superstructure to distribute the load. The deck is normally cantilevered from the ribs and considerable load is placed on the ribs when the deck is loaded. It probably will be necessary to support the deck by struts from the barge floor to the edge of the deck or by packing the gunwales. The load on the gunwale can also be reduced by using a reinforcing bent built up from the floor in the center of the barge. Barges with curved ribs must be braced by rods between the gunwales or by struts from the reinforcing bent (fig 20–10—20–13). If ribs are

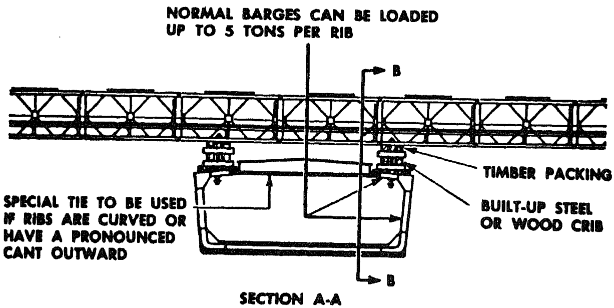


Figure 20–10. Adapting barges for gunwale loading. Section A–A.

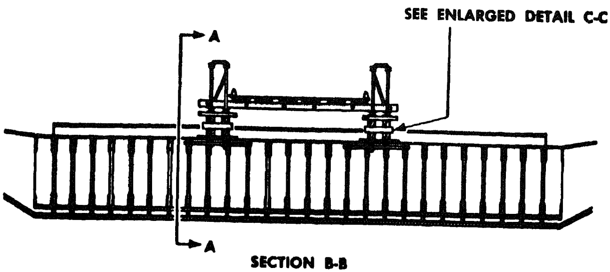


Figure 20–11. Adapting barges for gunwale loading. Section B–B.

not curved and the length of rib from deck to keel does not exceed 10 feet, reinforcing of ribs is not necessary.

b. Crib Loading. Cribs made of panel crib parts (chap 17) can be used to support the superstructure on the barge if the barge is unsuitable for gunwale loading or uneven grounding occurs. Barge floors are designed to carry distributed loads, and grillage must be used under the cribs to insure adequate distribution of the load. Crib loading requires more time for construction than gunwale loading but crib loading distributes the load to the floor of the barge, which is capable of carrying more load than the gunwales. It is essential to observe the behavior of cribs when the bridge is first loaded and during tidal changes. The position of bearings should be marked so that movements can be determined. If careful observations are made, adjustments can be made in time to prevent serious movements and avoid the difficulty of repositioning barges and correcting misalinement of superstructure. Secure anchorage of cribs will prevent most of this difficulty. The two types of cribs are fixed and rocking.

(1) *Fixed cribs.* Fixed cribs are used in both flat-bottomed and keeled barges that do not ground during low water. They are also used in keeled barges that ground during low water. to prevent the barge from tipping. Fixed cribs are rigidly connected to both the superstructure and the barge floor and guyed both laterally and longitudinally to the gunwale. Details of assembly and methods of attaching the cribs to the superstructure and the barge floor are similar to those given in chapter 17.

(2) *Rocking cribs.* Rocking cribs are used in

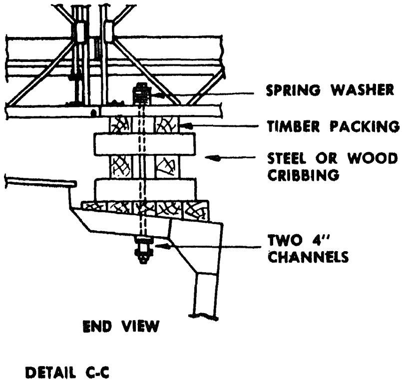


Figure 20–12. Adapting barges for gunwale loading. Detail C–C, end view.

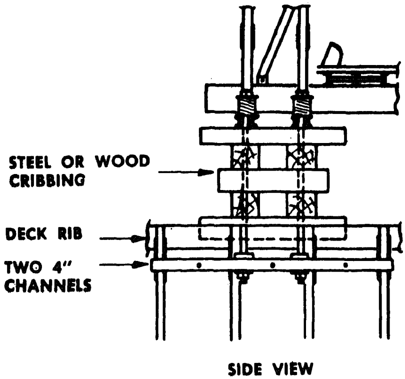


Figure 20–13. Adapting barges for gunwale loading. Detail C–C, side view.

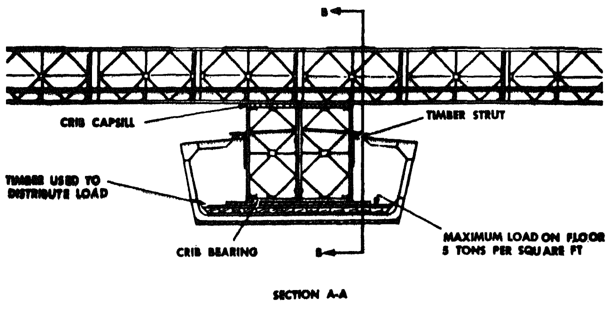


Figure 20–14. Expedient rocking crib. Floating barge using panel cribbing. Section A–A.

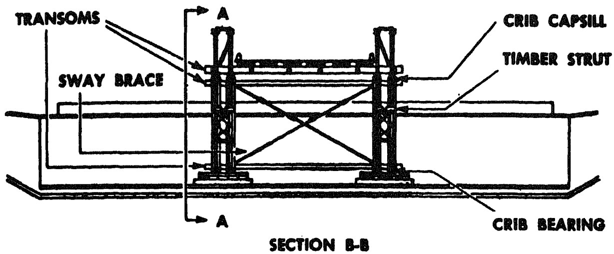


Figure 20–15. Expedient rocking crib. Floating barge using panel cribbing. Section B–B.

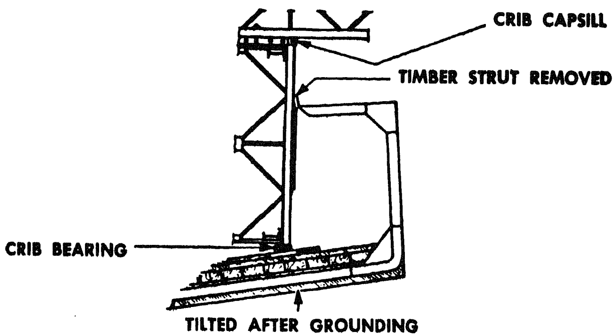


Figure 20–16. Expedient rocking crib. Grounded barge using panel cribbing.

flat-bottomed barges when uneven grounding occurs. Details of assembly and methods of making the rocking connections are given in chapter 17. Clearance between the crib and the gunwale must be enough to permit the full articulation required. The required clearance can be determined from the slope of the stream bottom where the grounding occurs. Rocking cribs are guyed fore and aft on the centerline of the barge as an additional safeguard against movement. An expedient rocking crib is shown in figures 20–14 through 20–16. The crib is made to rock by removing one of the panel pins in the crib bearing before the barge has grounded.

c. Grillage Loading. Grillage loading is used when the barge is unsuitable for gunwale loading and the panel crib pier parts are not available. Grillages are built up from the floor of the barge with steel or timber beams (fig 20–17). When grillage loading is used, care should be taken in bracing and typing of grillage and in insuring adequate distribution of the load on the floor of the barge.

20–19. Piers

a. Landing-Bay Piers. Both types of landing-bay piers are prepared in a similar manner (fig 20–18 and 20–19). Since the intermediate landing-bay pier acts as a compensator in ramping, it always has a higher elevation than the landing-bay pier. Piers are built up to the required elevation using I-beams, bolted down or welded to prevent sliding. When special connecting posts are not used to connect landing bays, base plates are welded to the piers and standard bearings welded to the plates to support end posts.

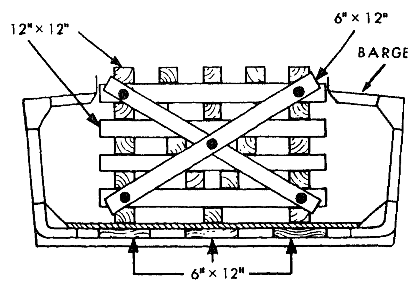


Figure 20–17. Section of timber grillage in barge.

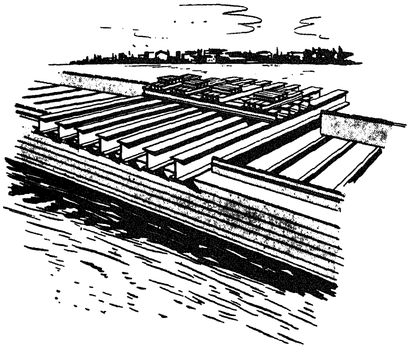


Figure 20–18. Preparation of intermediate landing-bay pier.

b. Floating-Bay Piers. Floating-bay piers are prepared similar to the landing-bay piers. Barges should be paired so those used in any pier have approximately the same freeboard. When the barges in the floating-bay piers have different freeboards, the superstructure seats must be cribbed up to the elevation of the superstructure seat on the barge with the greatest freeboard.

20–20. Landing Bays

a. Assembly. Normal assembly methods given in chapter 7 are used for assembling landing bays.

b. Launching. Several methods of launching landing bays can be used. Long spans are normally launched undecked.

(1) Where piers can be moved close to the bank, landing bays are launched over rollers on the bank to the pier. The skeleton tail (chap 18) method is used where bank conditions prevent moving barges in close.

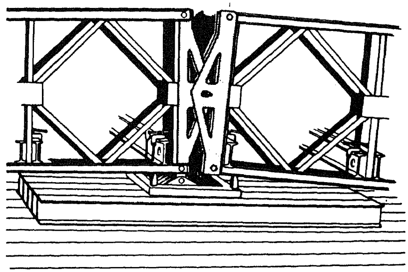


Figure 20–19. Bearing under special connecting post of variable landing bay.

(2) Where double landing bays are required, they can be launched as a continuous span, separately, or by use of construction barges.

(*a*) The two bays are assembled as a continuous span on the centerline of bridge abutment. This span is launched over rollers placed on intermediate landing-bay pier onto cribbing on the landing-bay pier. The top chord is broken over the intermediate pier by removing pins and then the river end is jacked into final position. Bottom pins are removed and the variable-slope bay is pulled back to permit installation of end fittings on the intermediate pier far both bays. Abutment fittings are placed in the usual manner.

(*b*) When launching separately, the fixed-slope bay is launched as described in (1) above except that rollers are placed on the intermediate pier instead of the bank. The variable-slope bay is then launched as described in (1) above.

(*c*) The fixed-slope bay can be assembled off site and launched to position on the intermediate floating-bay pier and a construction barge. The bay thus formed is floated into position and connected to the end floating bay. The construc-

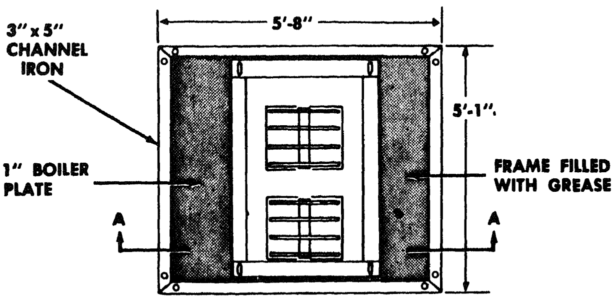


Figure 20–20. Shore sliding base plate in place, plan.

tion barge is removed. The variable-slope bay is then launched as in (1) above.

20–21. Floating Bays

a. Assembly. Methods given in chapter .7 are used for assembling floating bays.

b. Launching. Several methods of launching floating bays can be used.

(1) Where barges can be placed close to the bank, the span is launched over rollers on the bank to the off-bank barge. The barge is then pushed out, permitting the in-bank barge to be positioned. The span is then jacked down into place on the in-bank barge. A construction barge can be placed adjacent to shore to use jacks on. This should have a lower freeboard than other barges.

(2) Where bank conditions permit, both barges can be moored side by side and the span launched over rollers on the in-bank barge to a position on the off-bank barge. The off-bank barge is pushed out until the span is in position over the in-bank barge and then the span is jacked down into position on the in-bank barge.

(3) When barges have wide beams, sections of the bridge can be assembled on each barge and then joined to form bays; for long bays, surplus barges are partially flooded and floated from under the superstructure.

(4) Cranes can place bridge equipment on barges, where it can be assembled on rollers. Barges are spread to obtain proper bay length as superstructure is assembled.

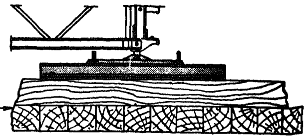


Figure 20–21. Shore sliding base plate in place, elevation.

20–22. Connecting Bridge Sections

a. Landing Bays.

(1) *Special connecting posts.* The use of special connecting posts for connection of all bays is desirable. Articulation provided is normally ample under all conditions. When both a fixed-slope landing bay and variable-slope landing bay are required, the special connecting posts on the river end of the variable-slope landing bays have bearing blocks welded to the bottom. The posts are seated on bearings welded to base plates which are welded to the intermediate landing-bay-pier grillage. The shore end of the variable-slope landing bay is fixed with standard end posts mounted on bearings welded to base plates. The base plates rest on rollers set in an expedient box plate (fig 20–20—20–22). This provides for lengthening and contraction of the bridge during changes in water level. The river and shore ends of the fixed-slope landing bay are suspended by treadway pins in the special connecting post.

(2) *Standard end posts.* Where special connecting posts are not available for connecting landing bays, the bays can be seated on standard end posts on bearings. End posts on adjacent ends

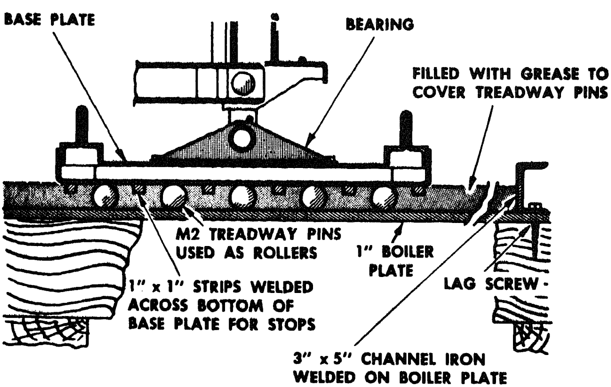


Figure 20–22. Shore sliding base plate in place, enlarged section A–A.

of variable slope and fixed-slope landing bays should rest on bearings welded to base plates mounted on the intermediate landing-bay-pier grillage. The river end of the fixed-slope landing bay is seated on standard end post bearings resting on base plates welded to the end floating-bay pier. The shore end of the variable-slope landing bay is mounted as described for special connection posts.

b. Floating Bays. Connection of floating bays is made easier by carefully constructing each bay to the same elevation. A ballast of water can be loaded for adjusting freeboard of the bay. A vehicle on the bay to be connected can be moved to aid in alining connecting pinholes.

(1) *Movement of bays for connection.* Considerable tug power is required to move and handle the bays into connecting position. The use of both towing and pusher tugs is necessary to provide adequate control of the bays to prevent damage. Floating bays over 100 feet long are difficult to tow and control.

(2) *Special connecting posts.* In connecting bays fitted with special connecting posts (fig 20–23), it may be necessary to jack the truss into place to obtain sufficient pin-hole alinement for the treadway pin.

(3) *Connection articulation.* Maximum articulation and movement of junctions between bays during grounding should be carefully estimated. Too much articulation will result in undesirable changes of slope in the decking and may cause tilting or lifting of stringers or chess. If such a condition develops at grounding, junction articulation can be minimized by use of a connecting span between the bays (para 20–23).

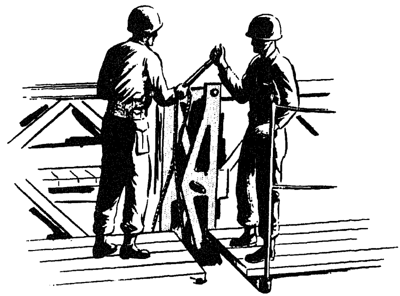


Figure 20–23. Connecting bays with special connecting posts. Jacking the truss.

Section VI. SPECIAL CONSTRUCTION

20–23. Connecting Spans

Connecting spans are normally 20 to 30 feet long. Each connecting span is assembled directly on a single construction barge at a correct elevation for connection in the bridge. Appropriate male and female connecting posts are installed at span ends to connect and suspend the span to girders of the adjacent bays in the bridge (para 20–26).

20–24. Lift Spans

The lift span (fig 20–4 and 20–24) is normally assembled on a construction barge at a correct elevation for connection in the bridge. The length and lift of the span are determined by the beam and clearance of the vessels to be passed through the bridge. To lift the span, panel towers are constructed on the ends of the adjacent floating bays. Suitable connectors, guides, and lifting and counterbalancing devices are installed on the towers for the control and lifting of the lift span. Connecting posts are installed at the ends of the lift span and girders of adjacent floating bays for connection when the span is lowered and in position to receive vehicular bridge traffic. Floating bays supporting the lift span must be designed to insure a level bridge.

20–25. Draw Spans

The length of the span is determined by the beam of the vessels to be passed. Towers are constructed on adjacent floating bays similar to lift span towers. Methods of constructing draw spans are as follows:

a. Draw spans can be assembled on a construction barge to correct elevation, and then moved and connected into the bridge.

b. One-half of the draw span can be added to each adjacent floating bay after tower erection at the bay assembly site. The two floating bays can then be connected into the bridge, and the draw span halves can then be connected.

c. Draw spans can be constructed by assembly of single girders on the deck of adjacent spans. These girders can be launched by using tackle from towers to support free ends. The girders are pinned to bays and then decked.

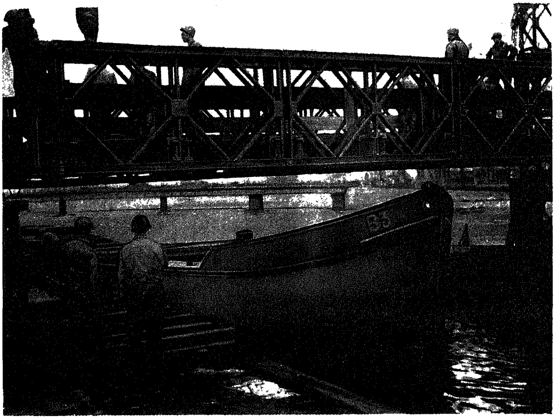


Figure 20–24. Lift span raised for river traffic. Note use of span junction posts.

20–26. Connecting Special Spans

a. Connecting Spans. When used to connect grounded bridge bays with special connecting posts, no special devices or maintenance will be required after the span is connected and suspended from girders of the adjacent bay ends.

b. Lift Spans. The lift span is connected to the supporting adjacent bays by special connecting posts or span junction posts when positioned and pinned for vehicular bridge traffic. A vertical guide system should be provided on the tower to control the longitudinal movement of the span during the lifting of the span to insure proper pinhole alinement for reinsertion of connecting pins upon lowering (fig 20–25).

c. Draw Span.

(1) A draw span is connected to its adjacent floating girders by means of a suspension link or hinge mechanism. The link consists of span junction posts.

(2) Decking must be arranged to allow for movement across junctions. Stringers are cut as shown in figure 20–9, one end being lashed down to the end transom of the draw span.

(3) The installation of a pair of span junction posts at the center of the draw span facilitates operation. The pins are readily removed when the weight of the draw span is taken on the tower tackles. In lifting the draw span halves, one side is raised until the jaws are clear. The panels are then levered sideways, if required, to enable simultaneous raising of the span halves without fouling.

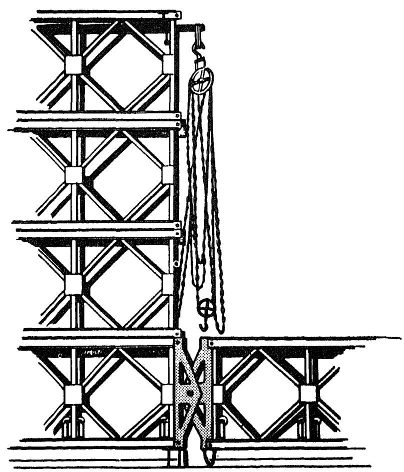


Figure 20–25. Panel tower and lift span connected and pinned for bridge traffic.

Section VII. ANCHORAGE

20–27. Anchors and Anchor Lines

The bridge should be secured by anchors and guy lines against the effect of wind and current (fig 20–26—20–28).

a. Anchors. Types of anchors required can be determined from an examination of the stream bottom and computation of expected pull on anchor lines due to current and wind. Barges

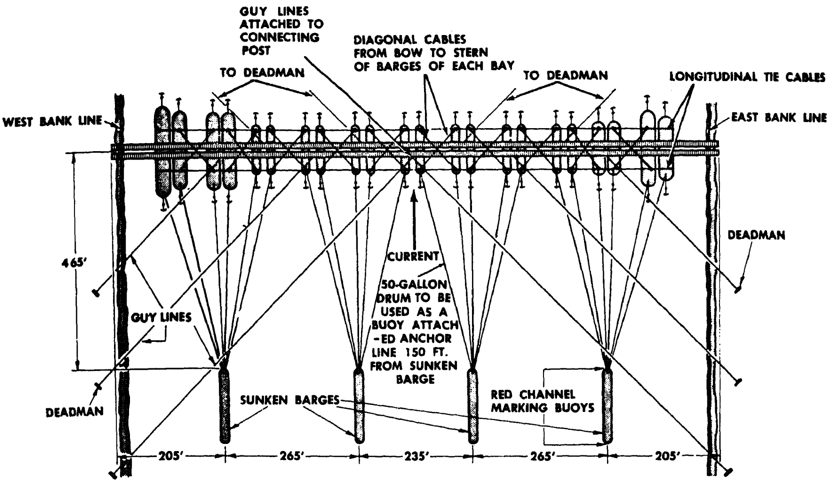


Figure 20–26. Suggested anchor and guy line systems. System used in barge bridge.

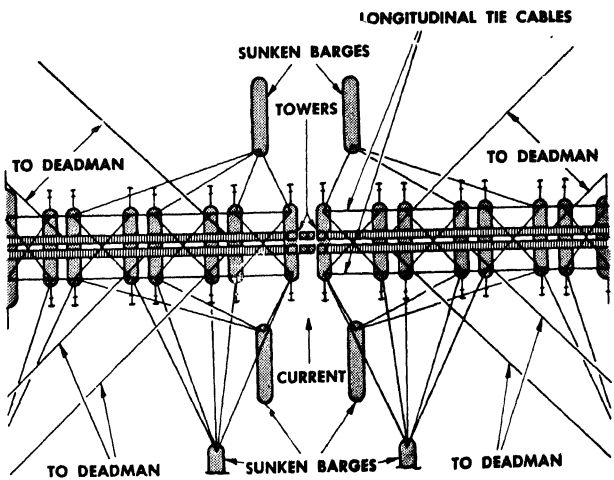


Figure 20–27. Suggested anchor and guy line systems. Modification for draw span.

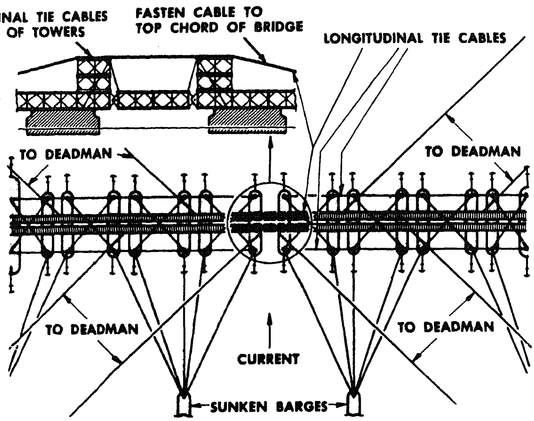


Figure 20–28. Suggested anchor and guy line systems. Modification for lift span.

loaded with stone or metal can be sunk upstream of bridge to serve as anchors.

b. Anchor Lines.

(1) Anchor line pull equals the sum of pull due to effect of current on submerged portion of barge and effect of wind on exposed portion of barge and superstructure. The following formulas may be used to determine this pull:

Pull due to current:

where

$P_1 = A_1v^2/P_1 =$ pull in pounds

$A_1 =$ vertical cross section area below waterline at beam of barge in square feet.

$v =$ velocity of current in feet per second.

Pull due to wind:

On barge:

where

$P_2 = 2A_2p/P_2 =$ pull in pounds

$A_2 =$ vertical cross section area above waterline at beam of barge in square feet.

$p =$ pressure (lb per square foot) for appropriate wind velocity in table 20–2.

On superstructure:

$$P_3 = \frac{2000}{10\,(L_1p_1 + L_2p_2 + L_3p_3}$$

Where $P_3 =$ pull in pounds.

$L =$ length in feet of superstructure of a particular type (table 20–2).

$p =$ pressure (tons per 10-foot length) for a particular type superstructure, at an appropriate wind velocity (table 20–2).

The pull due to current and wind is computed based on maximum expected conditions.

(2) Anchor lines should pull parallel to current.

(3) Winches should be placed on barges to adjust tension in anchor lines.

20–28. Guy Lines

a. Landing-bay piers are anchored to the riverbank by using guy lines. These lines should be placed at approximately a 45° angle to the bridge centerline.

Table 20–2. Wind Pressures

Wind pressure in tons per 10-foot length of superstructure

Type of bridge	Wind velocity (mph) 40	60	80	100
Single-single	0.09	0.19	0.34	0.53
Double-single	0.10	0.24	0.41	0.65
Triple-single	0.11	0.25	0.44	0.67
Double-double	0.18	0.40	0.72	1.12
Triple-double	0.20	0.45	0.80	1.24
Double-triple	0.28	0.64	1.13	1.77
Triple-triple	0.29	0.66	1.18	1.86

Wind pressure on vertical surface

Wind velocity mph	40	60	80	100
Wind pressure (lb per sq ft)	5.1	11.5	20.5	32.0

b. Longitudinal tie cables from stern-to-stern and bow-to-bow of each barge assist in keeping bridge alined and prevent longitudinal movement of parts of the bridge.

c. Special spans require modification of the anchor and guy system as shown in figures 20–27 and 20–28. In the lift span and draw span, the longitudinal tie cables must be broken to allow passage of river traffic. In lift spans, extra cables can be strung over the top of the towers to tie the bridge together over the gap. In draw spans, extra anchor barges may be sunk at each side of the gap to prevent the bridge from shifting when the span is open.

20–29. Anchorage of Grounding Barges

a. Barge Slide. A barge which tends to slide down the bank when grounded must be suitably anchored to the shore. Cables fastened to the bank can be passed under the barge to a connection on the off-bank gunwale of the barge. Packings must be used to prevent damage to the barge chines by the cables.

b. Landing Bay Slide. When a barge slides on grounding, the resulting shift in the superstructure may cause the landing bay to slide beyond the limits allowed for the bearings in the base plates. Tackle should be rigged to prevent further movement until the bearings and base plates are reinstalled and secured in proper position.

Section VIII. MAINTENANCE

20–30. Maintenance Detail

A detail of approximately one engineer combat company is required for maintenance of an 800-foot panel bridge on a 24-hour-a-day basis. Normally, two squads per shift are enough to tighten bolts, check anchor cables, repair decking, and maintain adequate bridge signs. On this basis, six squads in 24 hours are utilized, leaving a remainder of three squads to be detailed for the following duties:

a. Maintenance of approach roads.

b. Reserve for any major repairs required.

c. Crews for fireboat and standby tugs.

20–31. Duties

a. A duty officer should be detailed at the bridge 24 hours a day.

b. Bridge duty officer should insure that the following regulations are in force at all times:

(1) Communication must be maintained between the ends of the bridge.

(2) A wrecker must be available on call to remove disabled vehicles from the bridge.

(3) Guides having thorough knowledge of standard hand signals must be available to guide minimum clearance vehicles across the bridge.

(4) Alinement of the bridge must be constantly maintained.

(5) Tension in all anchor cables must be kept uniform.

(6) Buffers must be maintained between all anchor and guy cables that rub against metal.

(7) All cable connections must be inspected twice in 24 hours.

(8) All pins, bolts, and clamps must be inspected once in 24 hours.

(9) All barges must be inspected and bailed at least once in 24 hours.

(10) All base plates must be inspected once in 24 hours.

(11) Source of electrical power must be available for operation of trouble lights and tools.

(12) Immediate approach roads must be maintained.

(13) All signs in the vicinity of the bridge must be maintained.

(14) Traction strips and decking must be maintained. All nailheads must be kept flush with surface.

(15) Tugs must be stationed upstream and downstream at the bridge.

(16) Fireboat must be available.

Section IX. RAFTS

20–32. Use

Multiple-lane rafts can be assembled from panel-bridge equipment supported on barges. Such rafts can be used either as trail or free ferries in swift currents and rough water because of ample freeboard and stability.

20–33. Assembly

a. Normally, the raft superstructure is DS or TS assembly. For details of assembly and launching, see paragraph 20–20. For barge preparation, see paragraph 20–17.

b. A typical barge raft that was used success-

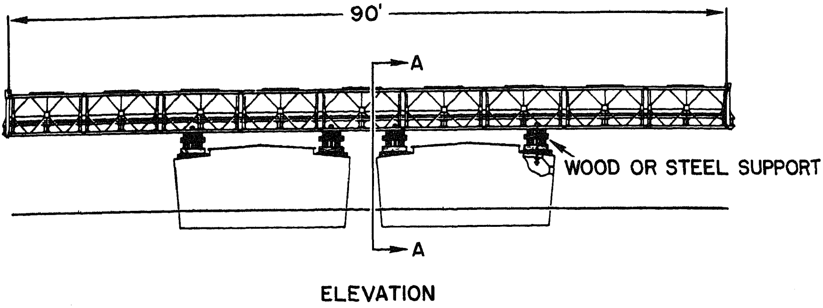


Figure 20–29. Typical barge raft. Elevation.

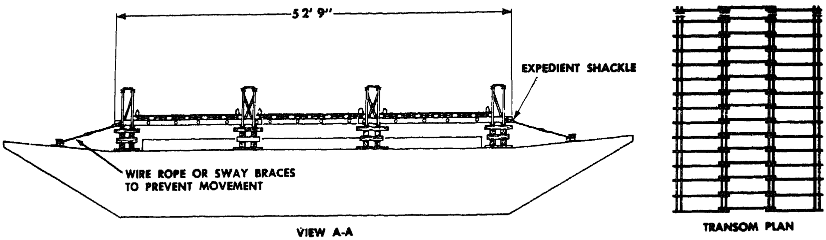


Figure 20–30. Typical barge raft. View A–A and transom plan.

fully is shown in figures 20–29 and 20–30. This raft has a three-carriageway superstructure of four DS girders 90 feet long on two 100-ton capacity Thames type barges. This raft accommodates 12 vehicles having a combined weight of 120 tons.

c. Inset position of barges in the raft as shown in figures 20–29 and 20–30 is necessary except in cases where the raft will be used in smooth water; otherwise, if the barges are placed near the ends of the raft, excessive stresses are induced in the connections between the barges and superstructure in rough water.

d. When towing the raft in heavy seas, the decks may become awash, causing complete bays of decking to lift off the barges. To prevent this, stringer clamps are used.

e. Superstructure must be secured to the barges to prevent fore and aft movement. Sway braces can be used for this purpose by fixing one end of the brace to a barge deck bollard or cleat and attaching the other end to a deck transom by means of two tie plates. The brace can then be tightened in the normal manner.

f. Assembly and operation of a raft is facilitated by use of quays or docks. It is preferable to operate between quays or docks of proper height for convenience in loading and unloading the raft. Where such site conditions exist, the height of the raft deck can be adjusted, within limits, by packing the superstructure girders up on cribs or by building a deck-type rather than a through-type raft. If quays or docks are not available, ramps can be constructed.

20–34. Operation

a. For continuous use of the raft as a ferry, an upstream cable can be installed. Bridle lines are run to winches mounted on the barges, allowing the raft to be swung at suitable angles to the current, and operate as a trail ferry.

b. In grounding the raft, it is possible that the barges will assume different angles of slope. To relieve the superstructure of stresses, either all top or all bottom pins at the center panel connections of the raft must be removed. This allows the two halves of the raft to articulate and conform to the lay of each barge. Close observation is required as the tide falls to determine whether the top or bottom pins are to be removed and also the proper time to remove them.

CHAPTER 21

TRAFFIC AIDS AND BRIDGE MAINTENANCE

21–1. Care of Parts and Equipment

a. Bridge Parts. When storing and transporting panel bridge parts, keep them clean and handle them as follows:

(1) *Panels.* Grease jaws and inside of all holes. Panels are easily distorted by improper storage and handling. Whenever possible, store them in an upright position resting on the long side. If it is necessary to store them horizontally for stability, do not stack more than 10 on a flat base. Stack on timber cribbing rather than on the ground.

(2) *Bracing frame, rakers, and tie plates.* Grease conical dowels.

(3) *End posts.* Grease curved bearing surfaces and pinholes.

(4) *Bearings.* Grease bar segments.

(5) *Panel pins.* Grease shanks.

(6) *Sway braces.* Grease threads and pins.

(7) *Bolts.* Grease entire bolt.

b. Erection Equipment. Protect pieces of erection equipment, such as rollers, jacks, panel levers, pin extractors, and wrenches, by keeping them clean and lubricated to prevent rust.

c. Roller Lubrication. Before launching a bridge, lubricate bearings of plain and rocking rollers through grease fittings at both ends of shafts. To lubricate plain rollers completely—

(1) Clean out old grease and dirt around shaft at each end of both rollers.

(2) Wedge rollers tight against outer bearings where grease fittings are located.

(3) Add grease until it is forced out around shaft at inner bearings.

(4) If no grease appears at inner bearing of either roller, disassemble and clean entire unit.

(5) After reassembling the roller, repeat steps (2) and (3).

21–2. Maintenance of Bridges

a. Maintenance Detail. For important bridges subject to enemy action, the maintenance party usually consists of the entire assembly crew. For routine repair work, however, the detail consists of only six men. In rear areas, one travelling crew maintains all bridges in an assigned area or route. The maintenance detail—

(1) Checks bridge thoroughly after first 30 minutes of use and periodically thereafter for tightness of bracing bolts, chord bolts, transom clamps, and sway braces.

(2) Examines base plates and grillages periodically for uneven settlement and adds grillage when necessary.

(3) Checks tightness of cribbing under end transoms and ramps.

(4) Makes sure all panel bridge pin retainers are in place.

(5) Lubricates all exposed threads and occasionally pours a small quantity of oil over each panel joint if the bridge is to remain in place for a long period or if it is to be dismantled in freezing weather.

(6) Repairs wearing surface on deck and ramps, and keeps stone and gravel off deck.

(7) Maintains immediate approaches and ditches.

(8) During heavy rainstorms, checks closely for erosion of bank seats, abutments, approaches, and drainage ditches.

(9) Replaces damaged endpost guards.

b. Tools. Tools for routine maintenance work are listed below.

Wrench, ratchet (for double-and triple- story bridges only)	1
Wrench, socket, 1⅛ inch	2
Wrench, structural, 1⅛ inch	2
Wrench, structural, 1⅞ inch	1
Wrecking bar	1
Clawhammer	1
Carpenter's level	1
Hand crosscut saw	1
Sledge, 6-pound	1
Shovel, long-handled	1

For bridges subject to enemy action, complete erection equipment must be kept available at the site.

c. Spare Parts. Bridge supplies include approximately 10 to 25 percent spares for all bridge and nose parts except bearings, ramp pedestals, pickets, base plates, ramps, and ribands. For replacing damaged parts of bridges subject to enemy fire, the spare parts in the bridge supply and additional parts covering the above exceptions are dispersed about the bridge site after completion of the bridge. Depending on the tactical situation, the spares may be increased up to 50 percent for forward area bridges. Rear area bridges require only enough spare deck parts and wear tread planking to replace those worn or damaged by normal use.

21–3. Traffic Control

To insure that vehicle drivers recognize and follow class and clearance restrictions, and to insure that vehicles come upon the bridge properly, traffic control measures are used.

a. Bridge Signs. Bridges and access roads are properly marked with standard NATO bridge and vehicle classification signs. These signs state the class, the roadway width, and the overhead clearance of the bridge. Details on the proper posting of NATO bridge signs may be found in FM 5–34, Engineer Field Data.

b. Traffic Guide. A traffic guide is posted at each end of long bridges or at one end of short bridges. His duties are to—

(1) Enforce traffic restrictions and bar unsafe vehicles. He determines the proper crossings of critical vehicles and bars all vehicles having vehicle class numbers exceeding the posted bridge class. He permits caution and risk crossings only when specifically authorized and in the presence of higher authority. (This higher authority must obtain appropriate theater or area approval of caution and risk crossings.)

(2) Keep traffic moving to avoid congestion.

(3) Arrange for alternate flow of traffic when necessary to keep the bridge exit clear. To avoid congestion, waiting vehicles are directed to park off the road.

(4) Stop traffic when bridge is damaged.

(5) Keep vehicles spaced properly and within specified speed limits for the type crossing authorized.

(6) Assist drivers of wide vehicles by furnishing instructions and signal guidance across the bridge.

(7) Maintain markers in a clean and easily recognizable condition. This is particularly necessary for the luminous painted panel verticals and roadway centerline *when used.*

c. Approach Guides. Approach guides are stationed on approach roads or at the intersection of the approach road with the main traffic net. They aid the bridge by controlling the traffic on the approach roads. Normally, units other than the bridge crew provide the approach guides.

d. Communications. The two guides on long bridges should have telephones to communicate with each other. Some form of communications is also, provided between the guides at the bridge and the guides on the approach roads.

21–4. Traffic Restrictions

Paragraph 5–16 outlines traffic restrictions for normal, caution, and risk crossings of panel bridges. The bridge deck width is normally restricted to 150 inches and the side trusses on the bridge restrict wide overhanging vehicles. An emergency expedient method for widening the roadway to accommodate certain extra wide non-US vehicles is explained in chapter 24. This expedient widening method permits caution crossings under restrictions outlined therein.

21–5. Bridge Marking

a. Markers. Luminous tape for distinguishing the bridge during blackout conditions are provided with the bridge set. The tape is attached to the approach posts and is not visible from the air. These markers help guide drivers to and through the bridge and help to keep traffic moving steadily. They may be arranged on the bridge and at the approaches in many different ways, according to the type of approach, length of the bridge, and light in the sky. Figure 21–1 shows a suggested arrangement of blackout markers on the approach and bridge. On the bridge, tape is placed on a level with the top of the bottom story.

b. Painting. As a further aid in night driving and particularly as a guide for very wide vehicles, a 4-inch wide centerline in the roadway should be painted with luminous or white paint. Additionally ribands, end posts, panel verticals, panel chords, and gusset plates may be painted with luminous or white paint. These painted markings aid in guiding wide vehicles in the daytime as well as guide all traffic at night (fig 21–2). Luminous painting must be used only when and where the tactical situation permits its use, since it might be seen from the air.

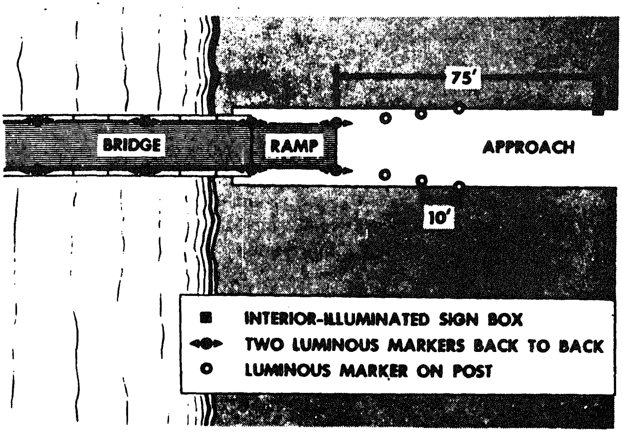


Figure 21–1. Arrangement of luminous markers on approach and on bridge.

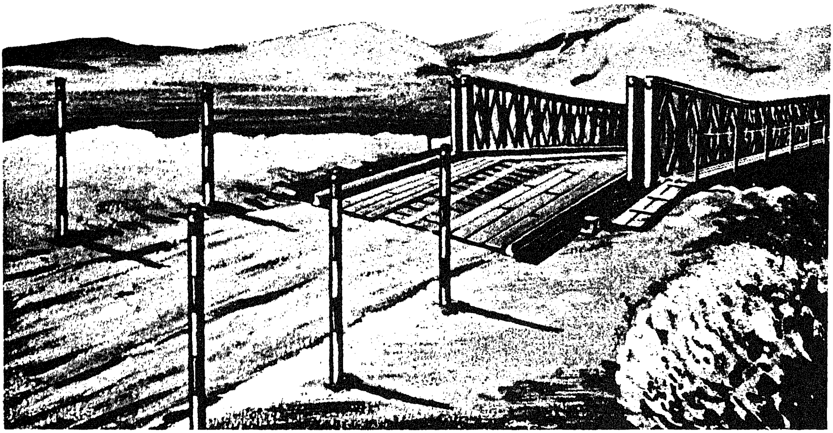


Figure 21–2. Bridge with painted centerline and panel posts to aid in night driving.

c. Height of Road Surface Above Ramp Flooring. To avoid shocks and possible displacement of the bridge from the impact of vehicles striking its end, build up the road surface to about an inch above the flooring of the ramp.

CHAPTER 22

REPAIR OF DAMAGED BRIDGES

Section I. ASSESSMENT OF DAMAGE

22–1. Basic Method

The class of damaged bridge is found by comparing the residual strength of a damaged member with the actual maximum stress it must take according to its position in the bridge.

22–2. Effect of Location of Damage

a. Panels. Unit assembly of the panel bridge produces girders of uniform section throughout their entire length. Many individual panel members are therefore not stressed to full capacity when the bridge is under maximum load. Only chords of the center bays and vertical and diagonal members of the end bays are fully stressed. Any damage to these members decreases the bridge class in direct proportion. Lightly stressed verticals and diagonals of the center bays, and chords of the end bays, can sustain considerable damage without affecting the bridge class.

b. Deck and Bracing Members. Since they can easily be replaced, the effect of damage to deck, transoms, sway braces, rakers, and bracing frames is not considered here.

22–3. Residual Strength of Damaged Panel Members

a. Verticals and Diagonals. Table 22–1 gives the residual strength of panel vertical and diagonal members expressed as percent maximum capacity of the complete cross section. The figures apply to both tension and compression members.

b. Chords. Residual strength of damaged panel chords is given in table 22–2. The two channels of a panel chord act as one member. Damage to one channel is indicated in the left column of the table and damage to the other channel is shown in the top row. Combined result of damage to the two channels expressed as a percentage of the strength of the undamaged chord is found at the intersection of the appropriate column and row.

22–4. Shear and Moment Distribution

a. Single-Story Bridges. To simplify calculations, shear and moment in single-story bridges are assumed to be taken equally by all trusses.

b. Double-Story Bridges.

(1) *Shear.* Shear in double-story bridges is taken equally by both stories, except in end bays where the bottom story takes 60 percent of the total shear.

(2) *Moment.* Top and bottom chords of double-story bridges provide all resistance to bending. Damage to intermediate chords can be disregarded if it does not reduce shear capacity of web-member connections.

c. Triple-Story Bridges.

Table 22–1. Residual Strength of Damaged Panel Verticals and Diagonals in Percent of Maximum Capacity of Full Section

	1" Dia. hole 					
100	85	70	50*	25	5	0

Table 22–2. Residual Strength of Damaged Panel Chords in Percent of Maximum Capacity of Full Section

DAMAGE TO NO 1 CHANNEL	DAMAGE TO NO 2 CHANNEL 1	2	3	4	5	6	7	8
1	100	50*	60	60	40*	55	55	5
2	50*	50*	45*	45*	35*	30*	30*	0
3	60	45*	40	60	30*	55	25	0
4	60	45*	60	40	30*	25	55	0
5	40*	35*	30*	30*	40*	15*	15*	0
6	55	30*	55	25	15*	10	50	0
7	55	30*	25	55	15*	50	10	0
8	5	0	0	0	0	0	0	0

*When length of damage exceeds 15 inches, values must be reduced to 0.

Note: Darkened portion indicates damage.

(1) *Shear.* Shear is taken equally by all three stories of a triple-story bridge except in end bays, as follows:

(*a*) Only bottom and middle stories resist shear when deck is in the bottom story.

(*b*) Only middle and top stories resist shear when deck is in the middle story.

(2) *Moment.* Stress in top and bottom chords of triple-story bridges is approximately three times that in intermediate chords. However, to simplify calculations, it can be assumed that top and bottom chords provide all bending resistance. Damage to intermediate chords causing loss of chord capacity up to 50 percent need not be considered, but cases of more extensive damage should be investigated and correlated with any damage in top or bottom chords of the same bay.

22–5. Shear and Moment Table

Table 22–3 gives maximum shear and bending moment in each bay of all spans of fixed panel bridges expressed as percentages of maximum capacity. Dead-load shear and moment values (DL) show percentage of shear and moment capacity of each bay required to support dead weight of the bridge itself. Live load values (LL) show percentage of shear and moment capacity of each bay required to support a tank load of the weight class of the bridge. Tank loads are placed at maximum eccen-

tricity against one curb, increased 10 percent for impact, and moved along bridge to point of maximum effect for each bay.

22–6. Evaluation of Damage

a. Bridge. The two main girders of a bridge are independent of each other and each must be capable of taking at least half the total bridge loads. If one girder is damaged it cannot be assisted by any reserve capacity of the other.

b. Girder.

(1) *Chords.* The members at a given section of a bridge which have an identical function and act together must be considered as a unit. For example, each main girder of a TD bridge consists of three trusses. If a chord of one truss is completely severed, the remaining undamaged construction of that girder is DD and capacity of the bridge is that of a DD bridge of the same span. Moreover, if the damaged truss is incapable of supporting itself, the DD capacity must be further reduced by half the weight in tons of the damaged truss. If the chord in one panel of SS bridge is completely severed, the capacity of the girder and bridge is reduced to zero.

(2) *Web members.* Effect of damage to diagonals and verticals depends partly on the condition of adjacent members as shown below.

(*a*) When both diagonals at a vertical section of a panel are seriously damaged, shear strength of the panel at that section is reduced to 30 percent because shear is resisted only by bending in the chords. Any damage to the chords or other diagonals in the same half of the panel reduces the shear strength to zero.

(*b*) When one of the diagonals at a vertical section is completely severed, panel shear strength at the section is reduced to 50 percent. Each diagonal takes half the shear, one in compression and the other in tension.

(*c*) Residual shear capacities of panels with damaged verticals in percent of undamaged capacity are shown in table 22–4.

Table 22–4. Residual Shear Capacity of Panels with Severed Verticals in Percent of Undamaged Capacity

Location of damage	End verticals			Center verticals			End verticals at end posts		
	Upper half	Lower half	Both halves or through gusset	Upper half	Lower half	Both halves or through gusset	Upper half	Lower half	Both halves or through gusset
First story	70	50*	30*	80	0	0	70	30	30
Second story	70	70	30	80	80	0	100	0	0
Third story	70	70	30	80	80	0	100	100	100

*When both verticals at panel junction point are severed, these values are reduced to zero.

c. Deformed Members. When a member struck by flying metal is deformed and not severed, it must be watched as loads pass over the bridge. If further deformation takes place, it must be treated as if it were severed.

d. Example.

(1) *Given.* A 90-foot span, class 40 DS bridge damaged as follows:

(*a*) *Case 1.* In the third bay from one end, a flange of one channel in the bottom chord of one truss is missing.

(*b*) *Case 2.* In the second bay from the end, a flange of one diagonal channel is severed.

(*c*) *Case 3.* In the end bay, the center vertical of one panel is completely severed.

(2) *Required.* What is the load class of the damaged bridge without repair or reinforcement?

(3) *Solution.*

(*a*) *Case 1.* From table 22–2 the residual strength of the damaged chord is 60 percent. As there are two trusses, the residual strength of the girder is—

$$\frac{100 + 60}{2} = 80 \text{ percent}$$

From table 22–3 bending stresses in the third bay are—

Dead load = 22
Live load = 67
Total 89 percent

The damaged girder section is capable of taking on 80 percent of its original capacity. Therefore, the rated bridge capacity must be lowered to reduce stresses at this section from 89 to 80 percent. Dead load remains the same. Therefore, live load must be reduced by 9 percent.

Live load $= 67 - 9 = 58$ percent

Reduction in live load is approximately proportional to the lowering of the load class.

or class 34

$$\text{New load class} = 40 \times \frac{58}{67} = 34.6$$

(*b*) *Case 2.* From table 22–1 residual strength of the diagonal with one flange severed is 25 percent.

Residual strength in panel =

$$\frac{25 + 100}{2} = 62.5\%$$

Residual strength in truss = 62.5%

Residual strength in girder =

$$\frac{62.5\% + 100}{2} = 81\%$$

From table 22–3 total shear in the second bay is 67 percent of maximum capacity, so this damage has no effect on the bridge class.

(*c*) *Case 3.* The center vertical of one panel being completely severed reduces shear capacity in that panel to 0 (table 22–4) with one truss carrying 0 percent shear and the other 100 percent shear. Therefore, the girder shear capacity is 50 percent. From table 22–3 shear in the end bay is—

Dead load =	21
Live load =	58
Total	79

Total load must therefore be reduced 29 percent to the girder shear capacity of 50 percent. With dead load remaining constant, allowable live load becomes—

$58 - 29 = 29$ percent.

$$\text{Load class} = \frac{29}{58} \times 40 = 20$$

Load class of the bridge is therefore determined by this damage to a center vertical in an end bay and must be lowered to class 20.

e. Example.

(1) *Given.* The 90-foot, US class 40 DS bridge of example *d* above has the chord of one truss in the third bay from one end completely severed.

(2) *Required.* What is the load class of the damaged bridge without repair or reinforcement if—

(*a*) *Case 1.* The damaged truss is capable of supporting its own weight?

(*b*) *Case 2.* The damaged truss is not capable of supporting its own weight?

(3) *Solution.*

(*a*) *Case 1.* From *b* above, capacity is reduced to that of an SS bridge of the same span or class 12.

(*b*) *Case 2.* From *b* above, capacity of the corresponding SS bridge must be further reduced by half the weight of the damaged truss. From table 1–1 the difference in weight of the two types of bridge bay is—

DS =	3.41 tons
SS =	2.76 tons
Difference	0.65 ton

The damaged truss, therefore weighs $9 \times 0.65 \times \frac{1}{2} = 2.93$ tons. Capacity of the 90-foot SS must be reduced by half this weight. New class $= 12 - 1.5 = 10.5$ or class 10.

Section II. REINFORCEMENT AND WELDING

22–7. Repair Methods

Damaged deck and bracing parts can be easily replaced with spares. However, replacing damaged panels is practically impossible without first delaunching bridge, which is difficult and time-consuming. If panel damage results in greater loss of capacity than can be tolerated, the bridge can be repaired by reinforcement or welding. Reinforcement is preferred because welding can cause serious additional damage unless it is done under favorable conditions by experienced personnel.

22–8. Reinforcement

a. Web Damage. Shear capacity lost by damage to panel vertical and diagonal members is restored by adding complete trusses or partial stories or replacing damaged bays.

(1) Repair damaged SS bridges by adding complete trusses.

(2) Use complete truss when damage extends through several bays of double-truss bridges.

(3) Add partial story when damage is confined to one or two bays on long spans. Partial story must extend two bays beyond both ends of damaged panels. In case of damage to first or second end bays partial story extends from end of bridge to two bays beyond damaged panels.

(4) If the end bay of double- or triple-story bridges is seriously damaged it must be replaced. Jack bridge onto launching rollers and build new bay at undamaged end of bridge. Roll new bay over gap, dismantle damaged bay, and lower bridge onto original bearings.

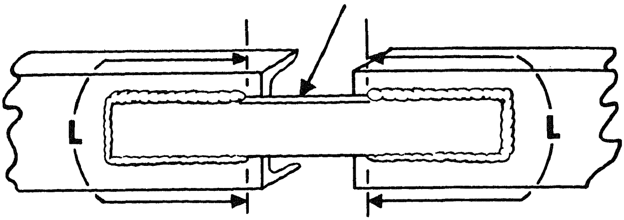


Figure 22–1. Effective length of weld on each end of splice plate.

b. Chord Damage. If chord and web damage occur together, repairs are made according to the above rules. Damage to exterior chords alone can be repaired with supplementary chords extending two bays on both sides of the damaged panel. Modified bracing frames must be used with supplementary-chord splices of the top chords of double- and triple-truss bridges to maintain a continuous bracing system.

c. Class.

(1) *Partial stories and supplementary chords.* The posted class of the bridge must be reduced by the dead weight of the partial story or chord splice.

(2) *Complete truss.* The capacity of a girder reinforced with a complete truss is determined by the method for assessment of damage in terms of reduction of load class.

22–9. Welding

a. Basic Considerations. All panel-bridge parts can be repaired by welding. Damaged parts which can be removed, however, are preferably replaced with spares. Repair work must be carefully done to prevent distortion and insure proper fit of all parts.

b. Design. Splice plates secured by fillet welds are more reliable than butt welding alone. Splice material should be mild steel plate about 50 percent greater in cross-sectional area than damaged section of the member being repaired. Splice plates should be arranged to match as closely as possible the shape and position of the damaged section they replace. Minimum length in inches of ¼-inch fillet weld required on each end of a splice plate is 10 times the cross-sectional area of the plate in square inches (fig 22–1).

¼-inch weld: L (inches) = $10 \times$ A (square inches)

If ⅜-inch fillet welds are used, the factor is 7 instead of 10.

⅜-inch weld: L (inches = $7 \times$ A (square inches)

c. Procedure.

(1) *Preliminary Work.* Before making welded repairs, it is necessary to clear the area around the fracture by cutting all jagged edges. *Straightening is always done cold.*

(2) *Welding technique.* Both mild- and high-tensile loy-allow steels of American parts can be repaired by either electric-arc or oxyacetylene welding. For electric-arc welding, the heavily coated mild-steel shielded-arc electrode (Lincoln Fleetweld No. 5 or equal) included in the electric arc-welding set No. 1, is the most satisfactory. If welding is done by the oxy-acetylene process, a copper coated mild-steel rod should be used.

d. Panel Repair. Cases of typical chord damage with correct repair are shown in figure 22–2. Figure 22–3 shows typical damage repair of panel web members. It is possible to use a standard set of strips in many cases, the more useful sizes being 3½ by ¼ by 12 inches; and 1½ by ¼ by 12 inches. The choice of strip sizes is determined by the requirement of using downhand welding wherever possible.

e. Repair of Removable Parts. Removable parts can be repaired using the same general procedure as for panel members. Splice plates on transoms must not interfere with stringers or positioning the transom seats on the girders. Welding of the lighter parts must be done carefully to prevent distortion and loss of interchangeability.

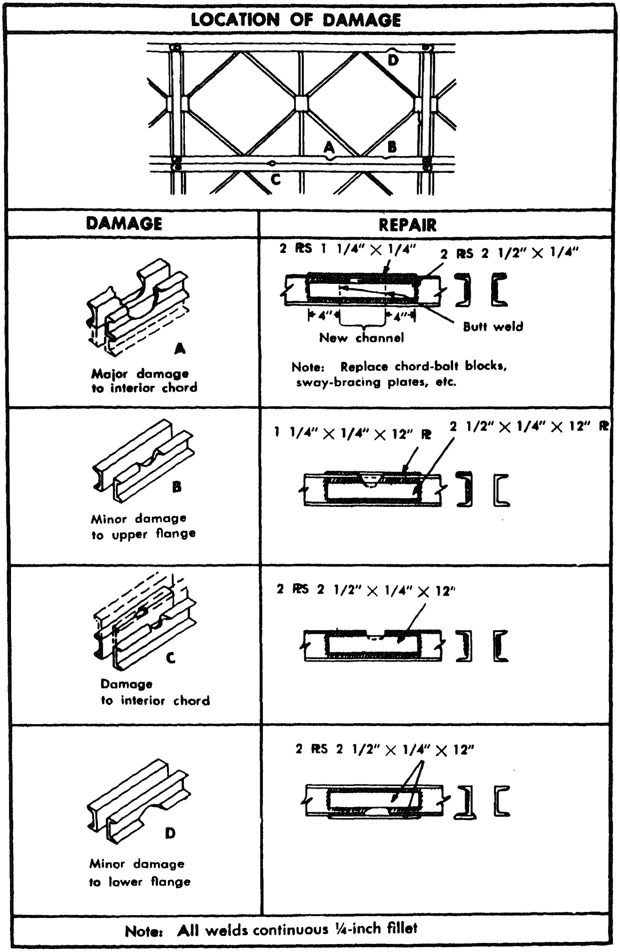


Figure 22–2. Typical panel chord welding repairs.

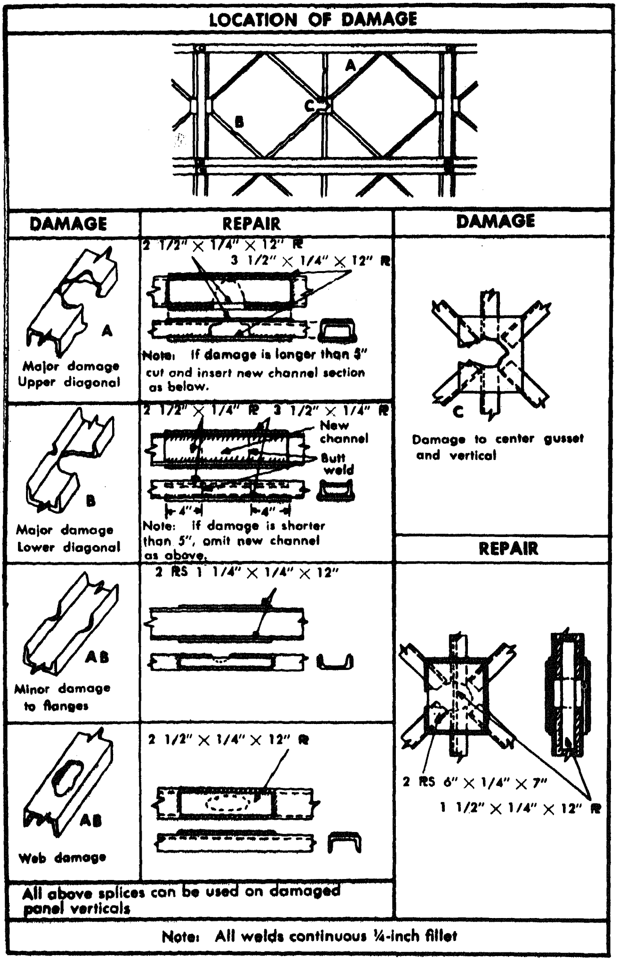


Figure 22–3. Typical panel web member welding repairs.

CHAPTER 23

DISMANTLING AND REPLACING BRIDGE

23–1. Dismantling Bridge

a. Action Required. Panel bridges are temporary structures and should be replaced as soon as practicable with semipermanent bridges. A panel bridge is dismantled in reverse of the order in which it was assembled. After dismantling, the panel bridge parts are returned to depot for reuse at another site.

b. Sequence. The proper sequence of operations in dismantling a panel bridge is—

(1) Take up ramps, jack up bridge, and place rocking rollers under each end and plain rollers on near-bank assembly site.

(2) Remove end posts and assemble launching nose or counter-weighted tail.

(3) Pull bridge back on near-bank plain rollers.

(4) Dismantle bridge and nose parts.

23–2. Replacing Bridge

While the new bridge is being constructed, some provision must be made to allow traffic to cross the gap. This can be done by building a bypass, by building the new bridge directly under the panel bridge, or by building the new bridge alongside the panel bridge and relocating the approaches.

a. Bypasses.

(1) Traffic can be diverted over a nearby bypass, such as a temporary bridge or culvert, while the panel bridge is being dismantled and the new bridge is being built.

(2) When a new two-lane bridge is being built, one lane is completed before the panel bridge is removed. This completed lane carries the traffic while the panel bridge is dismantled and the second lane is built.

b. New Bridge Construction Under Panel Bridge. When the new bridge is built directly under the panel bridge, traffic is interrupted only for a short time while the panel bridge is dismantled and the finishing touches are added to the new bridge deck and approaches. The new bridge can be either a timber trestle or a culvert with solid fill.

(1) *Timber trestles.* Timber trestle bridges can usually be constructed beneath the panel bridge so traffic can continue during most of the construction. At difficult sites, the panel bridge can be used as a working platform for driving piles or erecting trestle.

(2) *Culverts.* Culverts can be constructed directly underneath the panel bridge and an earth fill built up to the underside of the panel bridge. This fill is compacted, if only a shallow fill, and surfaced after the panel bridge is removed.

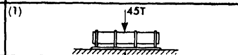
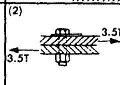
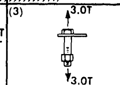
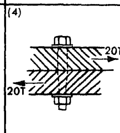
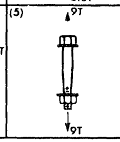
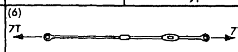
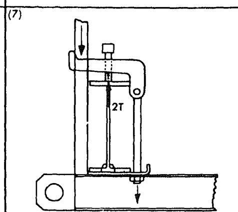
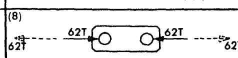
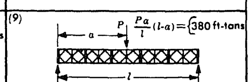
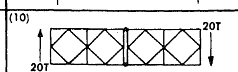
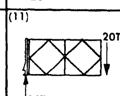
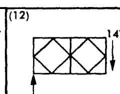
CHAPTER 24

EXPEDIENT USES OF PANEL BRIDGE EQUIPMENT

24–1. Strength of Panel Bridge Parts and Erection Equipment

Panel bridge parts are often used in the field to build improvised structures. To aid in their proper use, the capacities of the parts are given here. In all cases, allowance must be made for impact and load-distribution factors. Table 24-1

Table 24–1. Strength of M2 Panel-Bridge Parts

PART	LOAD	STRENGTH (TONS)	ILLUSTRATION
Bearing	(1) Concentric load	45	(1) 
Bolt, bracing	(2) Single shear (3) Tension	3.5 3.0	(2)  (3) 
Bolt, chord	(4) Single shear (5) Tension	20 9.0	(4)  (5) 
Brace, sway	(6) Tension	7.0	(6) 
Clamp, transom	(7) Maximum vertical clamp load when clamping transom in panel.	2.0	(7) 
Link, launching-nose MKII	(8) Compression or tension	62	(8) 
Panel as unit	(9) Moment of resistance to bending	380 ft-tons	(9) 
	(10) Shear across junction with both pins fitted	20	(10) 
	(11) End shear reaction with end post in single story (12) End shear without end post in single story	20 14	(11)  (12) 

gives the strength of M2 panel-bridge parts, and table 24–2 gives the strength of panel-bridge erection equipment.

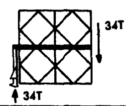
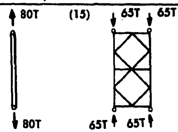
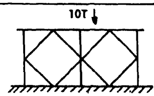
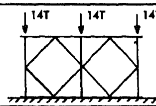
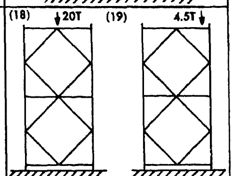
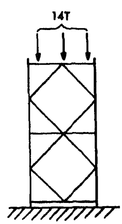
24–2. Expedient Decking for Panel Bridge

If stringers and chess are not available, an expedient deck can be laid on the transoms of a panel bridge. Timber or steel stringers with a wood floor can be used or steel treadways can be laid on the transom.

24–3. Expedient Widening of the Panel Bridge

a. Retention of Ribands. Normally, the roadway of the Bailey bridge is wide enough to handle all US vehicles. Some wide vehicles will have very little roadway clearance and require caution in entering the bridge; however, it has been found that the ribands should be retained on the bridge for these wide vehicles. The ribands assist in guiding the vehicles across the bridge and prevent damage to the bridge trusses. Certain non-US ve-

Table 24–1. Strength of M2 Panel-Bridge Parts—Continued

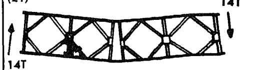
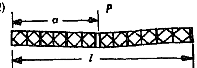
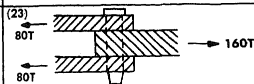
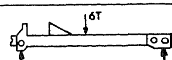
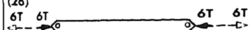
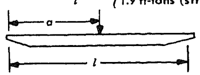
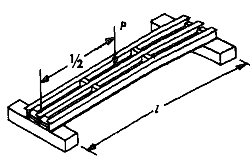
PART	LOAD	STRENGTH (TONS)	ILLUSTRATION
Panel as unit (continued)	(13) End shear reaction with end post in double or triple story	34	(13) 
Panel chord	(14) Tension	80	(14) (15) 
	(15) Compression	65	
	(16) Local bending, maximum load between panel web members	10	(16) 
Panel verticals	(17) Loaded as a strut	14	(17) 
	Loaded parallel to long axis of panel: (18) Concentrated load at mid-point	20	(18) (19) 
	(19) Concentrated load	4.5	
	(20) Equal concentrated loads at midpoint and adjacent to both prnel chords	14	(20) 

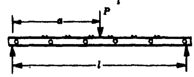
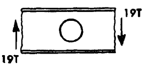
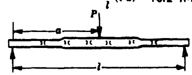
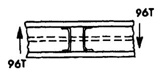
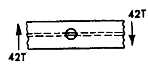
hicles are more than 150 inches wide, the normal panel bridge roadway width. To cross these, the ribands have to be removed.

b. Details of the Expedient Widened Bridge. By removing the ribands, a roadway width of 165 inches may be obtained. Normal chess, used for a guard rail, should be bolted to the panels just below the top chord of the bottom story as protection against damaging the truss panels. To secure the chess to the panels, carriage bolts with washers should be used with either steel plates or an additional plank behind the truss to bolt through. Limiting the wear tread to the normal width between curbs will allow the curbs to be replaced promptly after the wide vehicles have crossed. Prompt replacement of these curbs is necessary to insure the bridge's normal operating capacity.

c. Maintenance. A few crossings by tanks may quickly loosen the nails so that the treads must frequently be renailed. The guard rails may be left on the truss panels either with the widened roadway or the normal bridge.

Table 24-1. Strength of M2 Panel-Bridge Parts—Continued

PART	LOAD	STRENGTH (TONS)	ILLUSTRATION
Panel junction with launching link MK II	(21) Maximum shear	14	(21) 
	(22) Moment of resistance	380 ft-tons	(22)  $\frac{Pa}{l}(l-a) = 380$ ft-tons
Pin, panel	(23) Double shear	160	(23) 
Post, end	(24) Compression	25	(24) 
	(25) Concentrated load on center when used as beam supported at pinholes	6.0	(25) 
Raker	(26) Tension or compression	6.0	(26) 
Ramp	(27) Moment of resistance per beam	8.0 ft-tons	(27) $\frac{Pa}{l}(l-a) = \begin{cases} 8 \text{ ft-tons (ramp)} \\ 1.9 \text{ ft-tons (stringer)} \end{cases}$ 
	(28) Moment of resistance as whole, when point loaded at center	16 ft-tons	
Stringer	(27) Moment of resistance per beam	1.9 ft-tons	(28) 
	(28) Moment of resistance as whole, when point loaded at center	4.9 ft-tons	$\frac{Pl}{4} = \begin{cases} 16 \text{ ft-tons (ramp)} \\ 4.9 \text{ ft-tons (stringer)} \end{cases}$

PART	LOAD	STRENGTH (TONS)	ILLUSTRATION
Transom, M2 Normal position	(29) Moment of resistance to bending	64 ft-tons 56 ft-tons (reduced section)	(29) a = 0 to .34l and .66l to 1.0l $\frac{Pa}{l}(l-a)=56$ ft-tons a = .34l to .66l $\frac{Pa}{l}(l-a)=64$ ft-ton 
	(30) Maximum vertical shear	19	(30) 
Transom, M2 Lying on side	(31) Moment of resistance to bending	10.2 ft-tons 7.5 ft-tons (reduced section)	(31) a = 0 to .34l and .66l to 1.0l $\frac{Pa}{l}(l-a)=7.5$ ft-tons a = .34l to .66l $\frac{Pa}{l}(l-a)=10.2$ ft-ton 
	Maximum vertical shear: (32) Wide section	96	(32) 
	(33) Reduced section	42	(33) 

d. Capacities. The capacity of the widened bridge may vary some from the standard bridge due to the increased eccentricity possible in the widened bridge. Use normal capacities under caution restrictions at all times when the curbs are removed.

24–4. Spans Without End Posts

Single-story bridges can be built without end posts or bearings, the bridge resting on timber cribbing under the end vertical member of the end panels. However, this method of construction is not recommended unless absolutely necessary. When this is done, the transoms supporting the ends of the last bay of stringers must be supported by one of the methods given below.

a. End Transom Not Supported by Trusses. Place end transom outside the verticals of the panels and on grillage. Place an extra transom in the seating just inside the verticals of the end panel. Wedge blocking between these two transoms and lash them together. The ends of the stringers and ramps rest on and engage with the lugs of the end transom. Bolt bracing frames between the trusses at the end of the bridge. Table 24–3 lists the maximum spans that can be built with ends of the bridge supported in this way.

b. End Transom Supported on Trusses. Add an extra panel to the inner truss on each side of the bridge, and place a transom in this panel on the seating nearest the bridge proper. This transom supports the ends of the stringers and ramps. Place rakers on this transom and bracing frames between the trusses at the end of the bridge proper. Grillage under the end vertical is extended 2 feet on each side of the panel joint. Bridges of this assembly can carry the same load as corresponding bridges in *a* above. If the additional panel is added to all the trusses, the bridges can carry the same loads as corresponding bridges with end posts. In both cases, place cribbing

Table 24-2. Strength of Panel-Bridge Erection Equipment

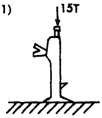
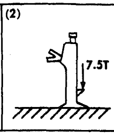
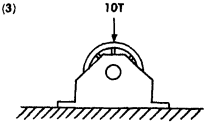
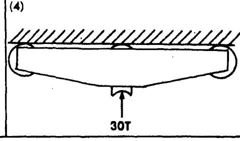
PART	LOAD	STRENGTH (TONS)	ILLUSTRATION	
Jack, ratchet	(1) Load on head (2) Load on toe	15 7.5	(1) 	(2) 
Roller, plain	(3) Maximum load	10	(3) 	
Roller, rocking	(4) Maximum load	30	(4) 	

Table 24-3. Limiting Spans for Bailey M2 Bridges w/o End Posts or Additional Panels

Span (ft.)	Type of Construction		
	SS	DS	TS
	Classes for normal crossings		
20 [1]	30/ /30		
30 [1]	20	75*/ /65	
40 [1]	17	50/ /50	
50 [1]		40/ /40	75*/ /70
60 [1]		35/ /35	60/ /60
70 [1]		30/ /30	50/ /55
80 [1]		30/ /30	45/ /50
90 [1]		27/ /30	45/ /50
100 [1]		25	40/ /45
110 [2]		24	35/ /40
120 [2]			30/ /35
130 [2]			24

*Classes 75 or above require four deck transoms per bay.
[1] Maximum allowable shear for bridge without end posts is 14 tons per truss. An allowance for 15% impact and variable eccentricity is made for live load.
[2] Moment governs, limits same as for bridge with end posts.

under the center of the end transom when loads are over 30 tons.

24–5. Causeways

Panel bridge decking can be used to build an expedient causeway over the soft mud of a tidal river bed. The causeway described here (fig 24–1) has a capacity of 45 tons and can be used at all stages of tide to load heavy vehicles such as medium tanks on rafts. Its roadway can have a slope up to 1 in 5 and is not affected by heavy tracked vehicles that would normally cause a roadway of landing mats on corduroy material to break up. Use of panel bridge equipment or causeways is expensive in equipment, however, and should be controlled carefully to prevent a shortage of panel bridge parts.

a. Details. The causeway consists of a normal panel bridge deck of chess, riband, and stringers supported on transoms set in ramp pedestals. To prevent scour and distribute the load, the pedestals rest on a foundation of landing mats and sapling mats (chess paling or similar material). Two pedestals are placed under each transom and the transoms are spaced 5 feet center-to-center. Precut 4- by 3-inch timber spacers, or rakers with timber wedges, are used between the pedestals to take longitudinal thrust. Sway bracing is threaded through the outside holes in the transom webs and held in place by bolts. The button stringers are wired to the transoms to prevent the decking from being lifted by the tide. A nonskid surface is provided by nailing down landing mat to the chess or wear treads. Steel ribands are used for curbing. Holdfasts at each side of the causeway are used to anchor bays having a steep slope.

b. Erection.

(1) About 100 man-hours are required t

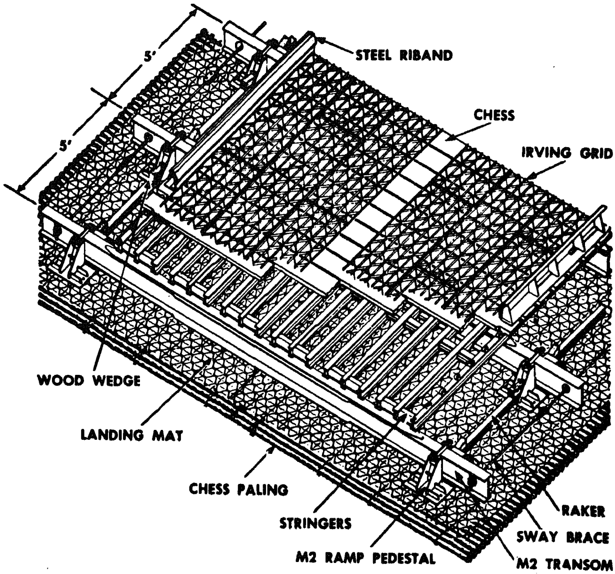


Figure 24–1. Panel bridge causeway.

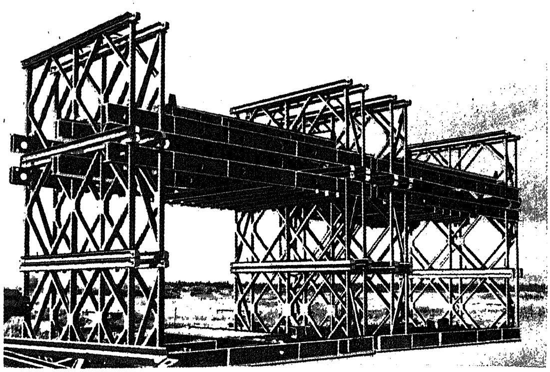


Figure 24–2. Constructing a ship-building gantry from panel bridge parts. To complete gantry, a monorail and traveling crane will be hung from overhead transoms.

erect 100 feet of this causeway. If the precut timber spacers are used instead of rakers with wedges, erection time can be reduced 25 percent.

(2) Place spacers at the same time as the pedestals, before transoms are laid. Do not tighten sway braces until stringers have been placed.

(3) The maintenance party keeps wedges, sway braces, and anchor lines tight.

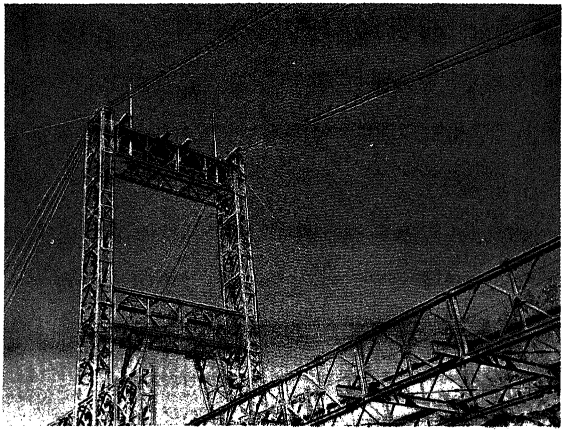


Figure 24–3. Bailey suspension bridge tower.

c. Operation.

(1) At low tide, and at high tide during construction of the causeway, vehicles generally can be loaded and unloaded at the end of the causeway. The overhanging deck or adjustable ramp of the raft rests on the end bay of the causeway so vehicles pass directly from the raft deck to the causeway. Where the causeway is begun at high tide, bays can be added at the rate of one bay in about 20 minutes as the tide lowers.

(2) At high tide, the lower end of the completed causeway is submerged and rafts are loaded and unloaded at the higher bays. An adjustable landing ramp hinged to the raft is used to bridge the gap between the causeway and shore end of the raft. The shoreward ponton can be grounded on the submerged causeway, but care must be taken to position the raft so the water is deep enough to permit maximum displacement when the shoreward ponton grounds.

24–6. Panel Box Anchors

An expedient heavy rubble box anchor can be made from four panels welded into a box with heavy wire net and filled with rock. Completely filled with rock, the anchor weighs about 10 tons. Heavy anchors of this type are used to anchor heavy floating bridges in swift currents and in streambeds in which the standard anchor will not hold.

24–7. Other Expedient Uses

Panel bridge parts can be used to build gantries (fig 24–2), anchorcable towers, high-line towers, towers for suspension bridges (fig 24–3), truck-loading traps, and other structures when building materials are not available. Angles and I-beams can be salvaged from damaged panel-bridge parts to be used for expedient construction.

CHAPTER 25

DEMOLITION OF BRIDGE AND PARTS

25–1. Objects of Destruction

The success of these demolition methods depends on the use of a uniform procedure by all units in the theater. All ranks must be impressed with the importance of following the principles stated in this chapter. The destruction must prevent both enemy use of the bridge as a unit and use of its parts for normal or improvised construction.

25–2. Methods of Destruction

a. To prevent use of the existing bridge, cut the trusses so the bridge will drop into the gap, and destroy the abutments.

b. To prevent reconstruction of a complete bridge, destroy one essential component not easily replaced or improvised. This component must be the same throughout the theater so replacements cannot be obtained from other sectors. The panel is the only component fulfilling these conditions.

c. To make a panel useless, remove or distort the female lug in the lower or tension chord. Destruction of both female lugs is unnecessary.

d. Always destroy all panels first. Certain other components such as transoms and decking useful to the enemy for improvised bridging should also be destroyed. Components, such as stringers, ramps, jacks, rollers, and erection tools, are destroyed only if time allows and explosives are available. Because the relative importance of these components varies considerably, follow the order of destruction given in paragraph 25–3.

25–3. Priorities

Panel-bridge equipment in danger of capture by

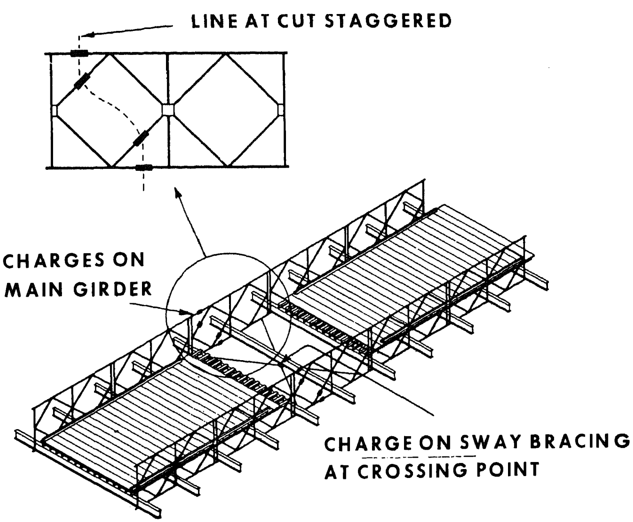


Figure 25–1. Destruction of assembled bridge. Placement of charges to collapse span.

the enemy is demolished in the following sequence:

a. Destroy Existing Bridge.

(1) *Entire bridge.* Collapse bridge by cutting the span and then destroy abutment.

(2) *Individual components.* If time permits, destroy individual components in the order used for stacked equipment (*b* below).

b. Destroy Stacked Equipment. Destroy stacks of panel-bridge equipment in the following order:

(1) Female lugs in lower chord of all panels.

(2) Transoms.

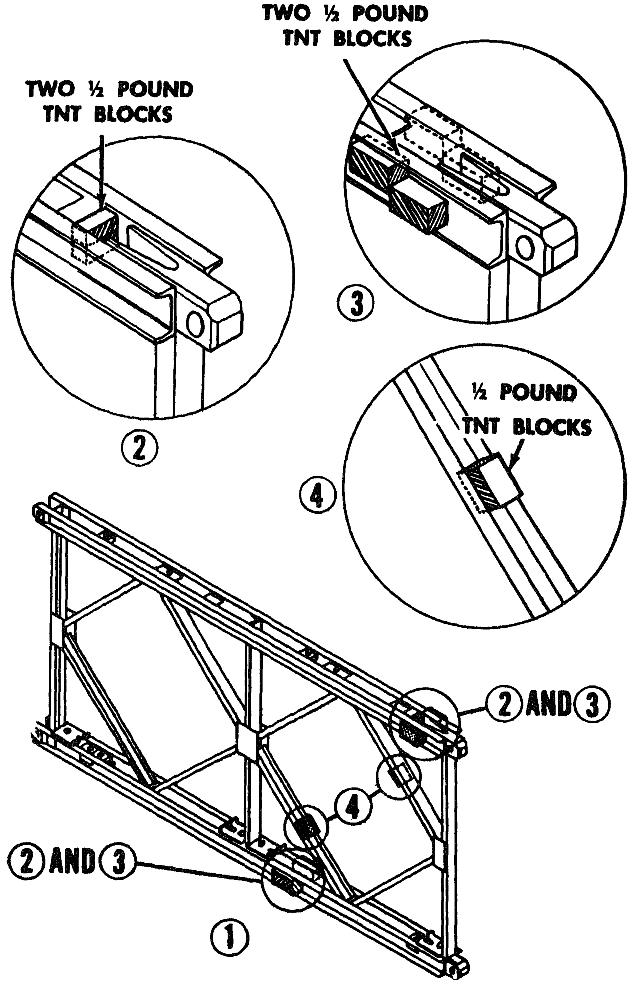


Figure 25–2. Destruction of assembled bridge. Placement of charges to cut panel in main girder. Wedging is not shown. For use of other explosives see table 25–1.

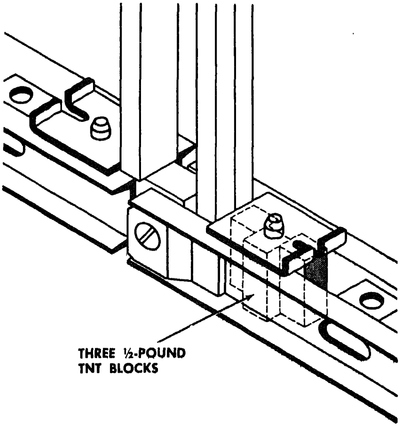


Figure 25-3. Destruction of parts of assembled bridge. Placement of charges to destroy lower female lugs pinned to adjoining panels. Charge wedged between channels behind end vertical at lower female lugs. Wedging is not shown. For use of other explosives see table 25-1.

(3) Chess.

(4) Stringers and ramps.

(5) Jacks, rollers, and erection tools.

(6) Remaining small parts.

25-4. Destruction of Bridge

a. Cut bridge in one or more places by cutting panels on each side of the bridge and sway braces in the same bay (fig 25-1). Stagger the line of cut through the panels (see inset, fig 25-1). Otherwise the top chords may jam and prevent the bridge from dropping. In double-or triple-story bridges increase the charges on the chords at the junction line of the stories.

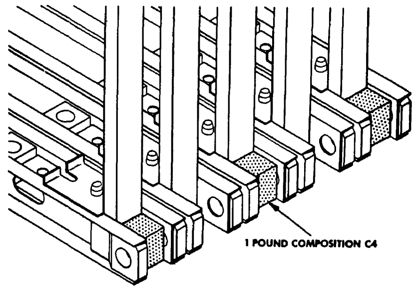


Figure 25-4. Destruction of stacked panels. Charge is placed between lower female lugs of alternate and end panels. Wedging is not shown. For use of other explosives see table 25-2.

b. For further destruction, place charges on component parts of the bridge, such as panels, transoms, and stringers (fig 25-2 and 25-3). Stack and burn decking.

c. Charges and methods of placing various explosives are given in table 25-1. Wedge all charges in place.

d. Use methods and charges described in FM 5-25 for destroying abutments.

25-5. Destruction of Stacked Equipment (figs 25-4 and 25-5)

a. Destroy panels and transoms in stacks. To dispose of stringers, ramps, jacks, rollers, small parts, and erection tools, dump them over large areas in places such as the sea, rivers, or woods. Burn decking.

b. Methods of destruction are described in table 25-2. Tamp all charges.

Table 25-1. Destruction of Assembled Bridge With its Component Parts

Part to be cut or destroyed	Placement of charge	Figure reference	Remarks	Preferred explosive	Charge: Individual	Charge: Total
Destruction of Assembled Bridge		25–1				
Panel		25–2				
	Chords: Between channels of chord	25–2	*Preferred method:* Uses less explosive. Wedging necessary. TNT blocks require excessive wedging.	Composition C4	1 lb	2 lb per panel.
	or Between flanges of channels on each side of chord.	25–2	*Alternate method:* For TNT blocks. Use wedging.	TNT	1 lb	4 lb per panel.
	Diagonals: Between flanges of channel	25–2	Use wedging	TNT	½ lb	1 lb per panel.
				Composition C4	½ lb	1 lb per panel.
Sway braces	A point where two braces cross	25–1	Tie charge to braces	TNT	2 lb	2 lb per pair braces.
				Composition C4	2 lb	2 lb per pair braces.
				Tetrytol	2½ lb	2½ lb per pair braces.
Destruction of Parts in Assembled Bridge.		25–3				
Panels lower-chord female lug (pinned to adjoining panel).	Between channels of lower chord behind end vertical.		Considerable wedging required with TNT blocks as they can only be inserted staggered.	TNT	1½ lb	1½ lb per lug.
				Compostiion C4	1½ lb	1½ lb per lug.
Transoms	On web		Use wedging	TNT	1 lb	1 lb per transom.
				Composition C4	1 lb	1 lb per transom.
Stringers	On web of each I-beam		Put charge on each of the three I-beams in each stringer. Use wedging.	TNT	1 lb	3 lb per stringer.
				Composition C4	1 lb	3 lb per stringer.
Chess			Remove from bridge, stack, and burn.			

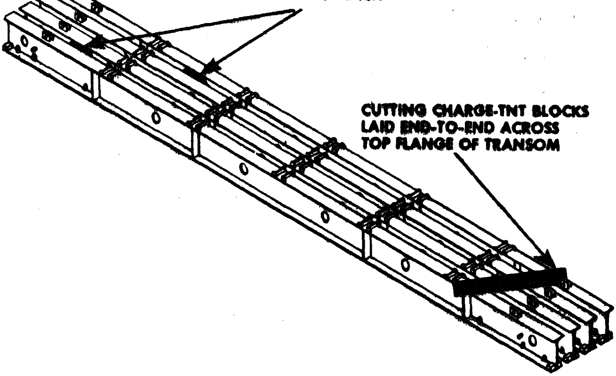


Figure 25–5. Destruction of stacked transoms. Lifting charge is placed between alternate transoms; cutting charge across top flanges of transoms. Wedging is not shown. For use of other explosives see table 25–2.

Table 25–2. Destruction of Stacked Equipment

Part to be cut or destroyed	Placement	Figure reference	Remarks	Preferred explosives	Charge: Individual	Charge: Total
Panels (stacked vertically or horizontally).	Between jaws of lower female lug, in alternate and end panels.	25–4	Use wedging. TNT blocks cannot be fitted between jaws.	Composition C4	1 lb	1 lb per two panels
Panels (stacked horizontally only)	Between channels of lower chord behind end vertical at female lug.	25–3	Use wedging	TNT	1½ lb	1½ lb per two panels
			Considerable wedging is required with TNT blocks as they can only be inserted staggered.	Composition C4	1½ lb	1½ lb per two panels
Transoms (stacked side-by-side).	Across top flange on an angle, and between alternate pairs of transoms at varying distances from end.	25–5	Use wedging	TNT	Enough to be laid end-to-end across top flange.	Approximately per transom.
			Blow both charges simultaneously to distort transoms and cut large pieces out of webs and top flanges.	Composition C4	1 lb between alternate transoms	1 lb per two transoms
Transoms (not stacked)	On web		Use wedging	TNT	1 lb	1 lb per transom
				Composition C4	1 lb	1 lb per transom
Chess			Spread out, thoroughly soak with gasoline or Diesel oil and burn. Ignite by exploding two or three strands of primacord wrapped around a can of gasoline.			
Stringers, ramps, ribands, jacks, rollers, and erection tools.			Scatter in sea, rivers, woods, or over a large area.			

APPENDIX A

REFERENCES

A–1. Field Manuals (FM)

5–1	Engineer Troop Organizations and Operations.
5–25	Explosives and Demolitions.
5–34	Engineer Field Data.
5–36	Route Reconnaissance and Classification.
21–30	Military Symbols.

A–2. Technical Manuals (TM)

5–210	Military Floating Bridge Equipment.
5–258	Pile Construction.
5–277K	Bridge Model, Training Aid Kit, Panel Bridge, M2 Bailey Type.
5–312	Military Fixed Bridges.
38–230–1	Preservation, Packaging, and Packing of Military Supplies and Equipment (Vol 1).

A–3. Other Publications

AR 310–50	Authorized Abbreviations and Brevity Codes.
TOE 5–77	Engineer Panel Bridge Company.
DA PAM 310-series	Military Publications Indexes (as applicable).

APPENDIX B

BASIC ISSUE ITEMS LIST, CABLE REINFORCEMENT SET

Section I. INTRODUCTION

B–1. Scope

This appendix lists items which accompany the cable reinforcement set or are required for installation or crew maintenance, and supplies required for initial operation.

B–2. General

This basic issue items list is divided into the following sections:

a. Basic Issue Items—Section II. A list of items which accompany the cable reinforcement set and are required by the crew for installation or maintenance.

b. Maintenance and Operating Supplies—Section III. A list of maintenance and operating supplies required for initial operation.

B–3. Explanation of Columns in Section II

a. Description, Column 1. This column gives the Federal item name and any additional description of the item required.

b. Quantity Incorporated in Unit, Column 2. This column gives the quantity of the item used in the set.

c. Illustration, Column 3. This column is divided as follows:

(1) *Figure number, column 3a.* This is the figure number of the illustration in which the item is shown.

(2) *Item number, column 3b.* This is the callout number used to reference the item in the illustration.

B–4. Explanation of Columns in Section III

a. Component Application, Column 1. This column identifies the component application of each maintenance or operating supply item.

b. Description, Column 2. This column gives the item name and a brief description.

c. Quantity Required for Initial Operation, Column 3. This column gives the quantity of each maintenance or operating supply item required for initial operation of the equipment. The abbreviation AR here and in column 4 stands for "as required"

d. Quantity Required for 8 Hours Operation, Column 4. This column gives the estimated quantities required for an average 8 hours of operation.

e. Notes, Column 5. This column gives informative notes keyed to data appearing in a preceding column.

Section II. BASIC ISSUE ITEMS

(1) Description	(2) Quantity included in unit	(3) Illustration (a) Figure No.	(b) Item No.
ACCESSORIES			
Chair, boatswain with safety belt 24 in. lg x 10 in. wide	4	B–1	1
Bag, lineman's tool, round	4		
Gage, cable tension, dial indicating 60 ton cap	3	B–1	2
Hose assy, short	8	B–1	3
Hose assy, long	6	B–1	3
Rope, manila 1200 ft coil, 2 in. circ	1	B–1	4
Wrench, box: Steel; slugging type; 12 pt; 2⅝ in	4	B–1	5

Section III. MAINTENANCE AND OPERATING SUPPLIES

(1) Component application	(2) Description	(3) Quantity Required f/initial operation	(4) Quantity Required f/8 hr operation	(5) Notes
Cable assy	Oil lubricating 5 gal can	AR	AR	Fed Spec VV–L–751.
Threaded parts and unpainted surfaces	Grease, general purpose	AR	AR	MIL–G–23549.
Cable tensioning	Oil, lubricating 1 gal can	AR	AR	MIL–L–10295.

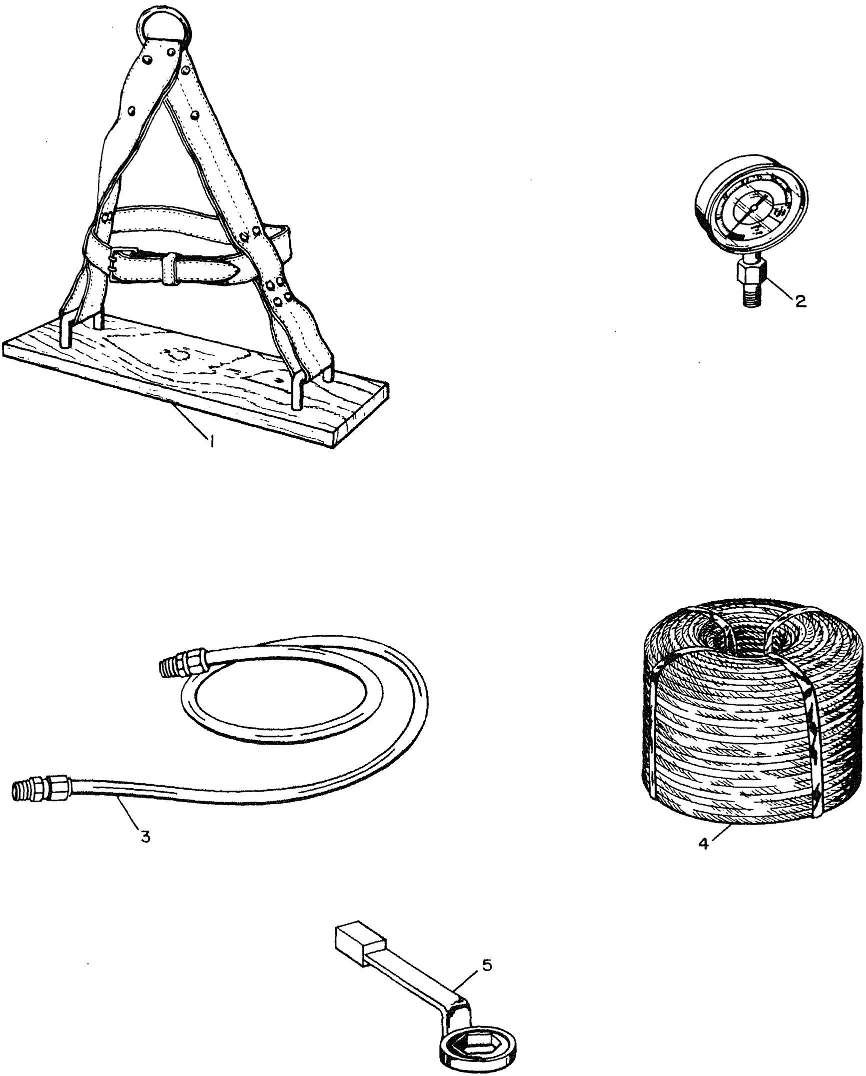


Figure B–1. Basic issue items.

APPENDIX C

REPAIR PARTS LIST, CABLE REINFORCEMENT SET

Section I. INTRODUCTION

C–1. Scope

Section II of this appendix lists the repair parts required for maintenance of the cable reinforcement set.

C–2. Explanation of Columns in Section II

a. *Description, Column 1.* This column gives the Federal item name and any additional description of the item required.

b. *Quantity Incorporated in Unit, Column 2.* This column gives the quantity of the item used in the assembly group.

c. *Illustration, Column 3.* This column is divided as follows:

(1) *Figure number, column 3a.* This is the figure number of the illustration in which the item is shown.

(2) *Item number, column 3b.* This is the callout number used to reference the item in the illustration.

C–3. Abbreviations

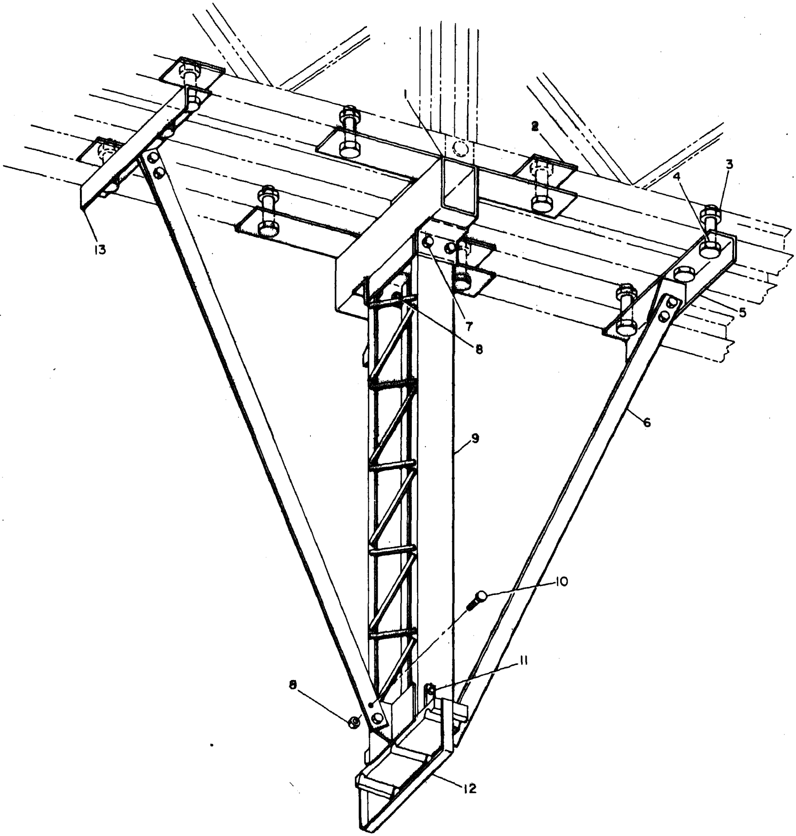
Abbreviation	*Explanation*
alw	allowance
assy	assembly
cad	cadmium
circ	circular
dia	diameter
ea	each
ft	foot (feet)
hex	hexagonal
hd	head
hyd	hydraulic
in.	inch (inches)
inc	inclosed
lg	long (length)
lh	left hand
meas	measure
No.	Number
NPT	National Pipe Thread
NPTF	National Pipe Thread Fine
pltd	plated
qty	quantity
rh	right hand
thd	thread (ed) (s)
wth	wide (width)

C–4. Federal Supply Codes for Manufacturers

Code	
26952	Enerpac Co. Division of Applied Power Industries, Inc., Butler, Wis.
45225	Owatonna Tool Co., Owatonna, Minn.
81348	Federal Specification
81349	Military Specification
82271	Waterman Hydraulic Corp., Skokie, Ill.
91561	Bruning Co., Lincoln, Neb.
96906	Military Standard
97403	MERDC, Fort Belvoir, Va.

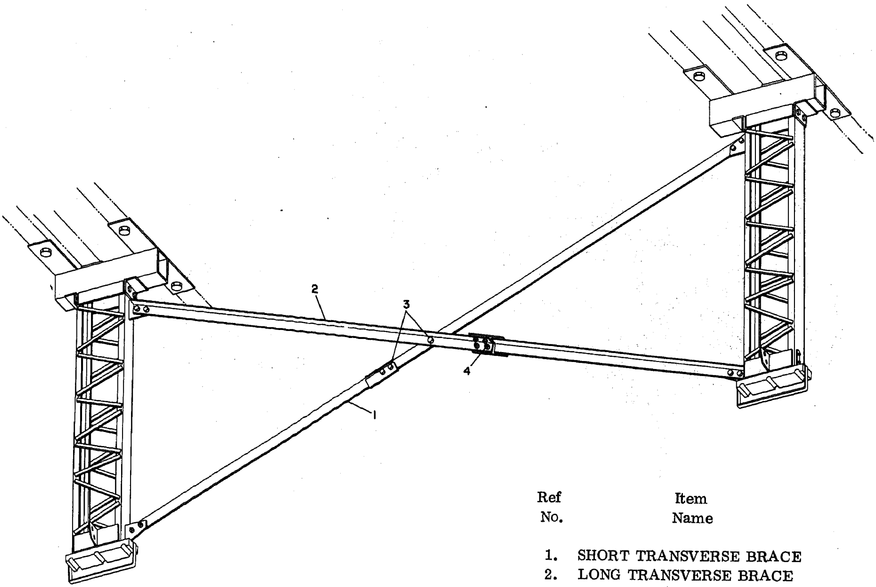
Section II. REPAIR PARTS LIST

(1) Description	(2) Quantity included in unit	(3) Illustration (a) Figure No.	(3) Illustration (b) Item No.
Adapter, hydraulic cylinder	6	C–4	18
Beam, cable connection, LH	2	C–3	1
Beam, cable connection, RH	2	C–3	1
Rocker, bridge seat: steel	6	C–3	4
Screw, cap: hex hd, steel, cad pltd, ¾ in. dia, 1½ in. lg 10UNC–2A	66	C–1 C–2	10 3
Screw, cap: hex hd, steel, cad pltd, ¾ in. dia. 2¾ in. lg, 10UNC–2A	16	C–1	7
Screw, cap: hex hd, steel, cad pltd, ½ in. dia, 4½ in. lg, 13UNC–2A	10	C–6 C–4	4 4
Bolt: hex hd, steel, 1¾ in. dia, 7 in. lg, 5UNC–2A	40	C–1	4
Brace, longitudinal: 8 ft ¼ in. lg	8	C–1	6
Brace, transverse: 7 ft 4¼ in. lg	4	C–2	1
Brace, transverse: 10 ft lg	4	C–2	2
Cable and reel assembly	6	C–4	1
Screw, cap: hex hd, steel, cad pltd, ½ in. dia, 1 in. lg, 13UNC–2A	6	C–4	2
Cable: 179 ft. 6 in. lg	6	C–4	1
Coupling, rod-to-cable	6	C–4	3
Fixture, brace connection, RH: 34 in. lg	4	C–1	5
Fixture, brace connection, LH: 34 in. lg	4	C–1	13
Fixture, post connection: 34¼ x 40 x 12 ⅜ inches	4	C–1	1
Nut, plain: hex, ½ in. dia, 13UNC–2B thd	10	C–4 C–6	5 5
Nut, heavy: hex, ¾ in. dia, 10UNC–2B thd	82	C–1 C–2	8 4
Nut, plain: hex, steel, 1¾ in. dia, cad pltd, 5UNC–2B thd	40	C–1	3
Plate, chord: steel, 7 x 7 x ⅜ inches		C–1	2
Retainer, cable, half; steel	6	C–3	3
Post, vertical: steel, 7 ft 1½ in. lg	4	C–1	9
Retainer, cable	4	C–1	12
Screw, cap: hex hd, steel, cad pltd, ½ in. dia, 1½ in. lg, 13 UNC–2A thd	16	C–1	11
Nut, plain: hex, steel, cad pltd, ½ in. dia, 13 UNC–2B thd	16	C–4	5
Reel, cable: 50 in. dia x 24¾ in. wide, 5½ in. center hole	6	C–6	1
Rod, pull: steel, 70 in. lg	6	C–4	6
Nut, serrated, cable & cylinder: 2 in. dia, 4½ UN–2B	12	C–4	7
Chain, pull rod: steel	2	C–4	19
Rope, manila: 2 in. circ x 1200 ft lg	1		
Shaft, cable reel: 3½ in. dia, 10 ft lg pipe	2	C–6	3
Hose and coupling assy, female: ¼ in. dia x 2 ft lg, with ¼ NPTF female quick-disconnect couplings each end	4	C–4	9
Hose and coupling assy, male: ¼ in. dia x 2 ft lg, with ¼ NPTF male quick-disconnect couplings each end	4	C–4	21
Hose and coupling assy, female: ¼ in. dia x 10 ft lg, with ¼ NPTF female quick-disconnect couplings each end	2	C–4	8
Hose and coupling assy, male: ¼ in. dia x 10 ft lg, with ¼ NPTF male quick-disconnect couplings each end	2	C–4	20
Hose and coupling assy, female: ¼ in. dia x 10 ft lg, with ¼ NPTF female quick-disconnect couplings each end	1	C–5	8
Hose and coupling assy, male: ¼ in. dia x 10 ft lg, with ¼ NPTF male quick-disconnect couplings each end	1	C–5	4
Support, cable reel: steel, 48 x 42 x 36 inches	4	C–6	2
Adapter, gage HP 2344: ⅜ x ⅜ x ¼ NPTF	2	C–5	3
Coupling, male half, (quick-disconnect) ¼ NPT	12	C–4	10
Coupling, female half, (quick-disconnect) ¼ NPT	12	C–4	11
Elbow, 90°: ¼ NPT	2	C–4	12
Valve, hydraulic, flow control: ¼ NPTF	2	C–4	13
Bushing: ⅜ NPTF x ¼ NPTF	4	C–4	14
Lug, jacking: steel	4		
Coupling, male half, (quick-disconnect) ¼ NPT	1	C–5	5
Coupling, female half, (quick-disconnect) ¼ NPT	1	C–5	6
Valve, hydraulic, flow control: ¼ NPT, 1908–2–2.0	1	C–5	7
Nipple: hex., ¼ NPTF	1	C–5	9
Bushing, pipe hexagon: ⅜ NPTF x ¼ NPTF	2	C–5	
Power unit, hydraulic:	2	C–4	15
Gage, cable tension, dial indicating	2	C–4	16
Cylinder, hydraulic, double acting	6	C–4	17
Pump, hydraulic ram, hand driven	1	C–5	1
Gage, cable tension, dial indicating	1	C–5	2
Post, span junction, female	6	C–7	1
Post, span junction, male	6	C–7	2



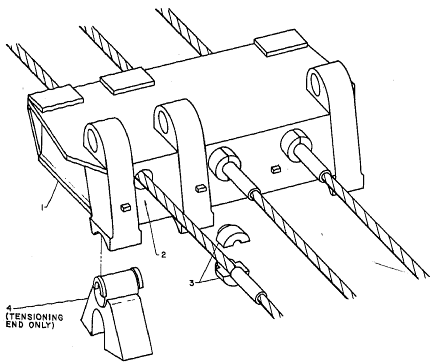
Ref No.	Item Name	Ref No.	Item Name •
1.	POST CONNECTION FIXTURE	7.	HIGH STRENGTH BOLT, 2-3/4 IN. LG
2.	CHORD PLATE	8.	HEX NUT, 3/4 IN. DIA
3.	HEX NUT, 1-3/4 IN. DIA	9.	VERTICAL POST
4.	CHORD BOLT, 7 IN. LG	10.	HIGH STRENGTH BOLT, 1-1/2 IN. LG
5.	BRACE CONNECTION FIXTURE, RH	11.	MACHINE BOLT, 1-1/2 IN. LG
6.	LONGITUDINAL BRACE	12.	CABLE RETAINER
		13.	BRACE CONNECTION FIXTURE, LH

Figure C–1. Post assembly, connection fixtures, braces, and related parts.



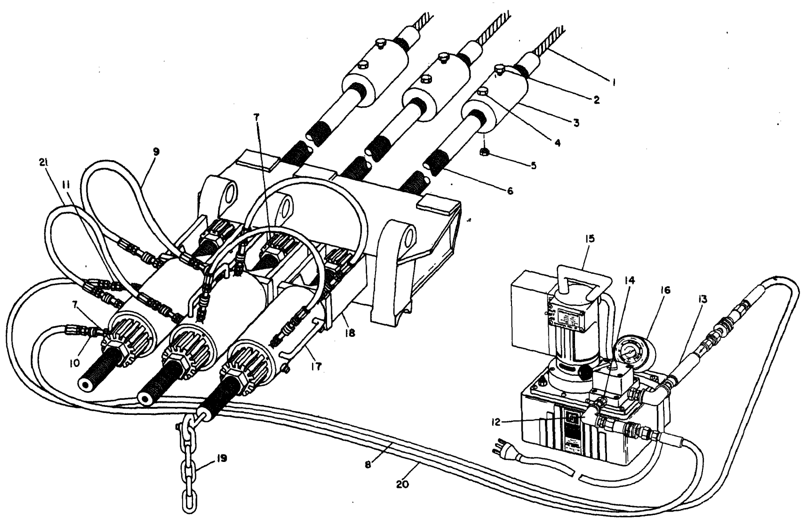
Ref No.	Item Name
1.	SHORT TRANSVERSE BRACE
2.	LONG TRANSVERSE BRACE
3.	BOLT, 1-1/2 IN. LG
4.	HEX NUT 3/4 IN. DIA

Figure C–2. Transverse braces.



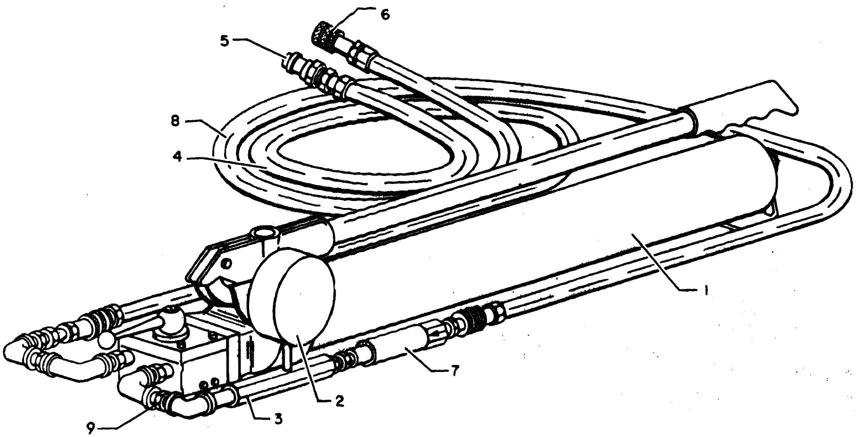
Ref No.	Item Name
1.	CABLE CONNECTION BEAM
2.	BEARING SURFACE
3.	HALF CABLE RETAINER
4.	BRIDGE SEAT ROCKER

Figure C–3. Cable connection beam and related parts.



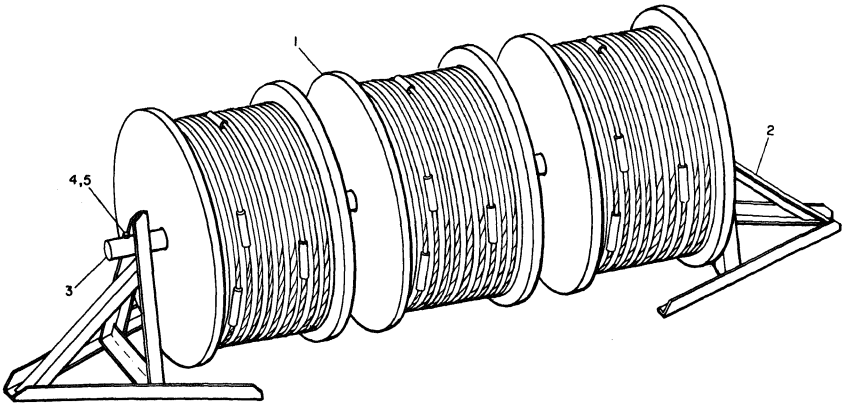
Ref. No.	Item Name	Ref. No.	Item Name
1.	CABLE	11.	FEMALE QUICK DISCONNECT COUPLING
2.	BOLT-TYPE SET SCREW	12.	90° ELBOW
3.	ROD TO CABLE COUPLING	13.	FLOW REGULATOR
4.	BOLT, 4-1/2 IN. LG	14.	BUSHING
5.	HEX NUT, 1/2 IN. DIA	15.	POWER UNIT, HYDRAULIC
6.	PULL ROD	16.	GAGE, DIAL INDICATING CABLE TENSION
7.	CABLE AND CYLINDER NUTS	17.	DOUBLE ACTING HYDRAULIC CYLINDER
8.	HOSE ASSEMBLY (LONG) FEMALE	18.	ADAPTER
9.	HOSE ASSEMBLY (SHORT) FEMALE	19.	PULL ROD CHAIN
10.	MALE QUICK DISCONNECT COUPLING	20.	HOSE ASSEMBLY (LONG) MALE
		21.	HOSE ASSEMBLY (SHORT) MALE

Figure C–4. Cable, pull rod, and hydraulic cylinder assemblies and related parts.



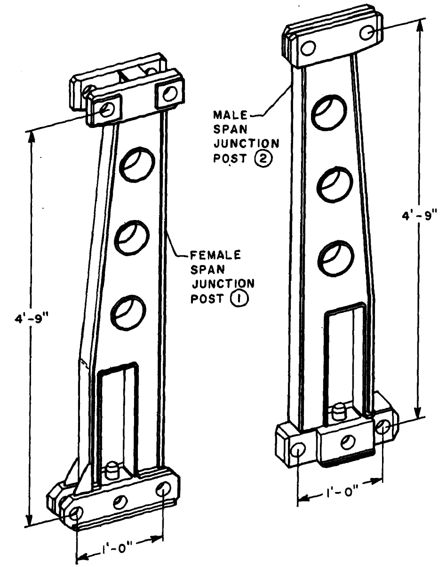
Ref. No.	Item Name
1.	HAND DRIVEN HYDRAULIC RAM PUMP
2.	DIAL INDICATING CABLE TENSION GAGE
3.	GAGE ADAPTER
4.	HOSE ASSEMBLY, MALE
5.	MALE QUICK DISCONNECT COUPLING
6.	FEMALE QUICK DISCONNECT COUPLING
7.	FLOW REGULATOR
8.	HOSE ASSEMBLY, FEMALE
9.	NIPPLE, PIPE, HEXAGON

Figure C–5. Manual hydraulic pump assembly.



Ref. No.	Item Name
1.	CABLE REEL
2.	CABLE REEL SUPPORT
3.	CABLE REEL SHAFT
4.	BOLT, 4-1/2 IN. LG
5.	HEX NUT, 1/2 IN. DIA

Figure C–6. Cable reel and related parts.



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APPENDIX E

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APPENDIX F

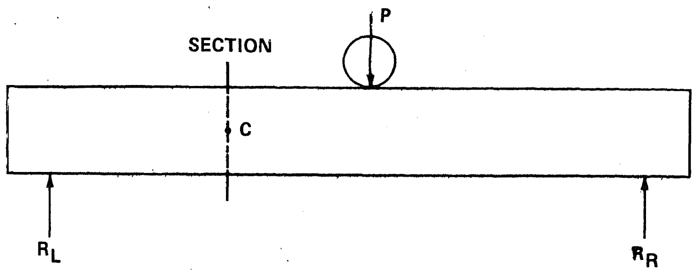
USE OF SALE CHARTS IN DETERMINING MOMENT AND SHEAR

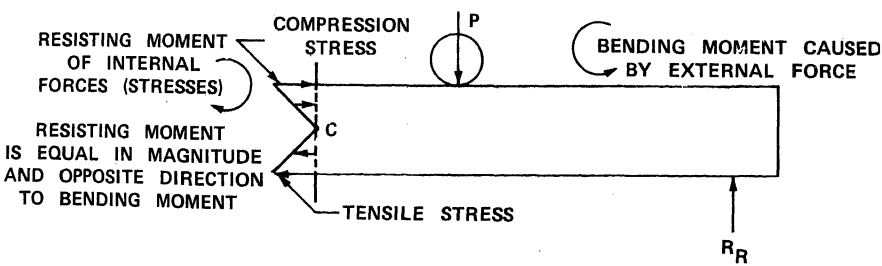
Section I. INTRODUCTION

F–1. Bending and Bending Stress

a. General. When a simple horizontal beam is loaded, it deflects, or bends downward, and the horizontal fibers in the lower part of the beam are lengthened (tension) and those in the upper part are shortened (compression). The external forces act to produce a *bending moment.* The moment of the internal forces (stresses) resisting this bending is called the *resisting moment.* In figure F–1, in that part of the beam to the right of section C, the counterclockwise bending moment produced by the external forces *P* and R_R is resisted by the clockwise resisting moment produced by the tensile and compressive stresses in the beam at section *C.* Within the strength of the material, the resisting moment at any section is equal to the bending moment at that section. When a beam is designed, the dimensions must be such that the maximum resisting moment that the beam can develop is at least equal to the greatest bending moment that may be imposed on it by the external loads.

b. Bending Moment. the bending moment at any section (point) of a beam for an external load in a specific position is found as follows: Determine reactions caused by load in this position. Take either reaction and multiply it by distance of that reaction from section under consideration; from this product, subtract product of each load applied to beam between reaction and section times the distance from that load to section. In figure F–2, external bending moment at C equals M_C =





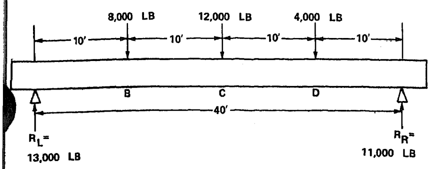


Figure F–2. Problem in bending.

$R_L \times 20 - 8{,}000 \times 10 = 260{,}000 - 80{,}000 = 180{,}000$ foot-pounds, or $M_C = 180{,}000 \times 12 = 2{,}160{,}000$ inch-pounds. This may also be found by taking forces from the right end. The bending moment at any point in a beam due to a moving load varies with the position of the load. For design, it is necessary to know the maximum moment that is caused by the load as it moves across the bridge.

(1) Maximum bending moment caused by a single concentrated axle load occurs at center of span when load is at center of span.

(2) Maximum bending moment produced by a uniformly distributed load occurs at center of span when distributed load covers entire span.

(3) If distributed load is shorter than span, maximum bending moment occurs at center of span when center of load is at center of span.

(4) The following formulas are useful in determining maximum bending moments caused by single loads on simple beams:

$M = \frac{Pl}{4}$. (Concentrated center load P.) $M = \frac{Wl}{8}$. (Total load W uniformly distributed over span l.) $M = \frac{wl^2}{8}$. (Load w per linear foot distributed over span l.) $M = \frac{W(2l - b)}{8}$. (Load W partially distributed over part of span l.) Where M = moment in inch-pounds at center of beam. P = concentrated load in pounds. W = total distributed load in pounds. w = distributed load per linear foot in pounds. l = span in inches. b = length of load in inches.

(5) Examples: What is the maximum bending moment produced in a 20-foot span by a single concentrated axle load of 30 tons? By a total load of 5 tons uniformly distributed over the span (dead load)? By a 30-ton tank that has 147 inches of track?

Solutions: For a single concentrated axle load of 30 tons:

$M = \frac{Pl}{4}$ where $P = 30$ tons, or 60,000 pounds, and $l = 20$ feet, or $20 \times 12 = 240$ inches. $M = \frac{60{,}000 \times 240}{4} = 3{,}600{,}000$ inch-pounds.

For a uniformly distributed load of 5 tons:
$M = \frac{Wl}{8} = \frac{10{,}000 \times 240}{8} = 300{,}000$ inch-pounds.

For a 30-ton tank:
$M = \frac{W\ (2l - b)}{8} = \frac{60{,}000\ \ (2 \times 240 - 147)}{8} =$
2,497,500 inch-pounds.

(6) For a series of axle loads on a span, maximum moment may occur under the heaviest load when that load is at the center of the span, or it may occur under one of the heavier loads when that load and the center of gravity of all the loads on the span are equidistant from the center of the span. Further details on computing maximum bending moment produced by two or more loads on a span can be found in engineering handbooks. For the design of military bridges the computation of maximum bending produced by a series of axle loads or that produced by a uniformly partially distributed load, such as a tank, has been simplified by the use of single-axle load equivalents (SALE). The SALE is that single-axle load that, when placed at midspan, will cause the same maximum moment as the maximum moment caused by the actual vehicle. From the formula above for a concentrated center load P and substituting SALE we have: $M = \frac{(SALE)\ l}{4}$.

c. Resisting Moment. Maximum allowable resisting moment that a beam can develop is the product of maximum allowable *fiber stress* for the material and *section modulus* of the beam, which is a measure of the capacity of the cross section of the beam to resist bending. Where M is the maximum allowable resisting moment that a beam can develop; f, the allowable extreme fiber stress for the material; and S, the section modulus, their relationship is expressed by the formula $M = fS$. S depends solely on shape and size of the cross section and f on the material of the beam. For rectangular beams, such as timber stringers, $S = \frac{bd^2}{6}$, where b and d are the breadth and depth of a section. For a round log, $S = \frac{d^3}{10}$, where d is the diameter. S for I-beams and other structural steel shapes may be found in tables in standard engineering handbooks. Values of S for selected I-beams and WF (wide flange) beams are given in tables F–1 and F–2. The stress f is ordi-

narily expressed in pounds per square inch, and b and d in inches, giving M in inch-pounds. Values of f will vary according to type of stress and type of material. For this text and the majority of field design, values as given in section II are used. For example, if the extreme allowable fiber stress (f) in bending of the wood in a rectangular beam 6 by 12 inches is 2,400 pounds per square inch, then the maximum allowable bending moment that that beam can resist is:

$$M = fS = f\frac{bd^2}{6} = (2400)\frac{(6)\ (12)\ (12)}{(6)} =$$

345,600 inch-pounds.

Table F-1. Properties of Selected American Standard I-Beams

Depth of beam (inches)	Width of flange (inches)	Weight per foot (pounds)	Section modulus (S) (inches)*
24	7⅛	106	234
24	7	80	174
20	7	81	147
20	6¼	65	117
18	6	55	88.4
15	6	61	81.2
15	5½	43	58.9
12	5¼	41	44.8
12	5	32	36.0
10	4⅝	25	24.4
8	4	18	14.2
7	3⅝	15	10.4
6	3⅜	13	7.3
5	3	10	4.8
4	2⅝	8	3.0
3	2⅜	6	1.7

*Some of these sections may not be available.

Table F-2. Properties of Selected Wide-Flange Beams

Depth of beam (inches)	Width of flange (inches)	Weight per foot (pounds)	Section modulus (S) (inches)*
36	16½	230	836
36	12	150	503
33	15¾	200	670
33	11½	125	385
30	15	172	528
30	10½	108	299
27	14	145	403
27	10	91	233
24	14	130	331
24	12	100	249
24	9	74	170
21	13	112	250
21	9	82	168
21	8¼	59	119
18	11¾	96	184
18	8¾	64	117
18	7½	47	82.3
16	11½	88	151
16	8½	58	94.1
16	7	36	56.3
14	14½	87	138
14	12	78	121
14	10	61	92.2
14	8	43	62.7
14	6¾	30	41.8
12	12	65	88.0
12	10	53	70.7
12	8	40	51.9
12	6½	25	30.9
10	10	49	54.6
10	8	33	35.0
10	5¾	21	21.5
8	8	31	27.4
8	6½	24	20.8
8	5¼	17	14.1

*Some of these sections may not be available.

F-2. Shear

a. Any load applied to a beam induces shearing stresses. There is a tendency for the beam to fail by dropping down between the supports (fig 6-3 (A)). This is called *vertical shear.* There is also a tendency for the fibers of the beam to slide past each other in a horizontal direction (fig F-3 (B)). The name given to this is *horizontal shear.*

b. For beams supported at both ends, the shear at any section (point on the beam) is equal to the reaction at one end of the beam minus all the loads between that end and the section in question. To calculate maximum shear, it is necessary to find the position of the loads that produces the greatest end reaction. This usually occurs when the heaviest load is over one support.

c. In timber we find that because of the layer effect of the grain, the stringers are weaker horizontally along the member. But the stress numerically equal to the horizontal direction is *numerically equal* to the vertical direction so design is on the basis of the stress in the vertical direction. In military bridge design a shear check must be *made if the span length in inches is less than 13 times the depth of the stringer.*

d. The average intensity of shear stress (horizontal and vertical) in a beam is obtained by dividing maximum external shear by cross-sectional area of the beam. However, shear is not evenly distributed throughout the beam from top to bottom, so maximum shear intensity is greater than the average. Maximum shear intensity occurs at the midpoint of the vertical section.

e. For a rectangular section, maximum horizontal shear intensity equals 3/2 times average intensity, or— $S_h = \frac{3V}{2bd}$.

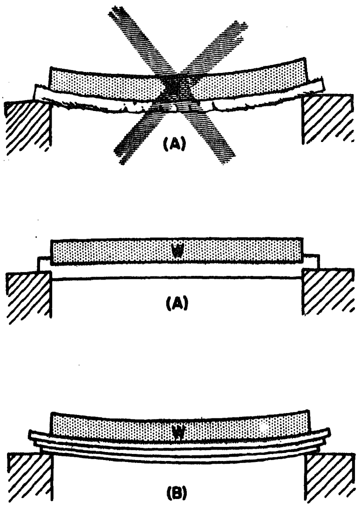


Figure F–3. Beam failure.

Where S_h = maximum shear intensity (unit shear stress) induced in the beam, in pounds per square inch. V = maximum shear, in pounds. b = breadth of beam, in inches. d = depth of beam, in inches.

f. Over short spans where shear rather than bending may control, beams warrant special means of analysis. In computing maximum horizontal shear intensity, use the formula given in *e* above. In determining V for use in this formula neglect all loads within a distance equal to or less than the beam height from either support and place the design moving load at a distance three times the height of the beam from the support.

g. For a circular section, maximum horizontal shear intensity equals $\frac{4}{3}$ times average intensity, or— $S_h = 1.7 \frac{V}{d^2}$.

Where d is diameter of beam, in inches.

Section II. CLASSIFICATION OF VEHICLES AND BRIDGES AND FIELD DESIGN

F–3. General

The purpose of this section is to outline office and field procedures for classifying vehicles and bridges in accordance with the vehicle and bridge classification system and to explain the field design of simple bridges. This section explains vehicle and bridge classification procedures in sufficient detail to enable engineers who are familiar with the classification system to determine the proper classification of vehicles and bridges. It also explains how to select stringers for simple-span bridges and to design the substructure using timber trestle intermediate supports.

F–4. Standard Classes

a. General. A group of 16 standard classes ranging from 4 to 150 has been established at the intervals shown in figure F–4. For each of the standard classes two hypothetical vehicles are assumed, a tracked vehicle whose weight in short tons is the standard class number and a wheeled vehicle of greater weight which induces approximately the same maximum stresses in a given span. For example, in standard class 4 the tracked vehicle weighs 4 tons, the wheeled vehicle 4.5 tons; in class 8, 8 tons and 9 tons, respectively. The hypothetical vehicles and their characteristics are shown in figure F–4. Although these vehicles are hypothetical, they approximate actual United States and United Kingdom army vehicles.

b. Standard Class Curves. For each standard class both a moment class curve and a shear class curve are drawn. These curves are determined by computing the maximum moment and maximum shear induced in simple spans by the two hypothetical vehicles for each standard class, converting these values to single-axle-load equivalents (SALE), in short tons, and plotting the SALE against the simple-beam span in feet. The envelope curve is then drawn through the maximum moment and shear values as shown in figures F–5 and F–6. The standard class curves are shown in figures F–7, F–8, F–9, F–10, F–11, and F–12. In computing the maximum moment and shear, vehicles are spaced at normal convoy spacing, with an interval of 30 yards from the tail of one vehicle to the front of the next vehicle.

F–5. Specifications

The basic assumptions and specifications used in this section for design and capacity estimation data are as follows:

a. Bending Stress.

(1) Steel—27,000 pounds per square inch.

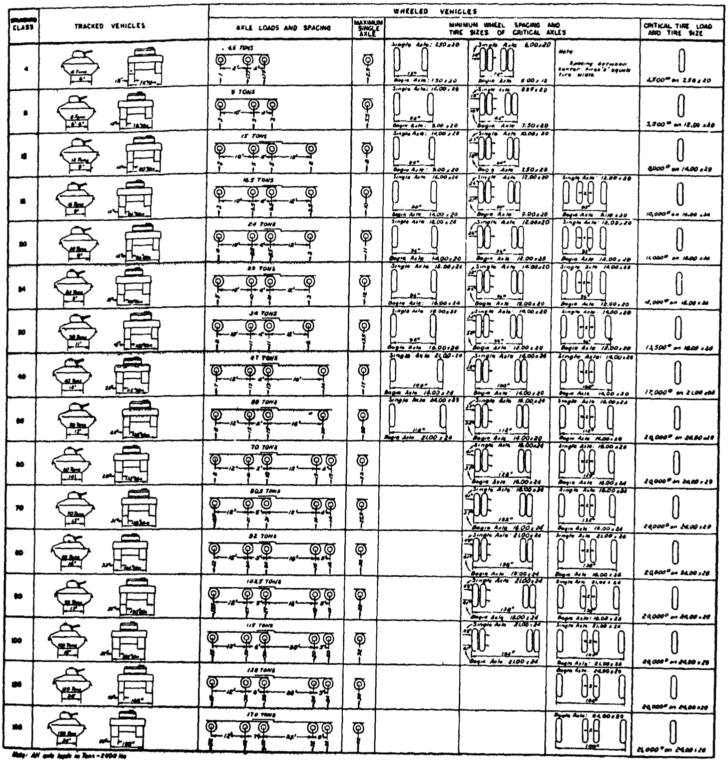


Figure F–4. Standard class, hypothetical vehicles and vehicle characteristics.

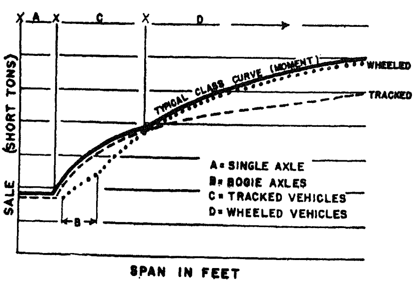


Figure F–5. Typical standard class curve (moment).

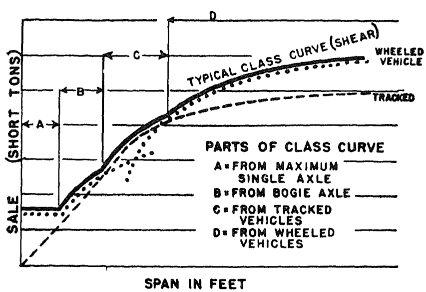


Figure F–6. Typical standard class curve (shear).

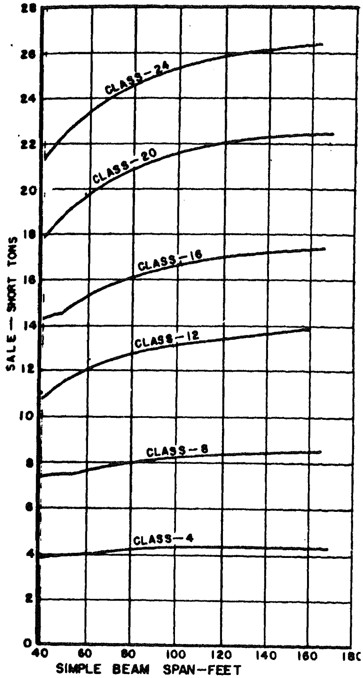


Figure F–7. Standard class curves (moment), 4 to 24.

(2) Timber—2,400 pounds per square inch.

b. Shear Stress.

(1) Structural steel sections—16,500 pounds per square inch.

(2) Steel pins and rivets—20,000 pounds per square inch.

(3) Timber—150 pounds per square inch.

c. Impact.

(1) Steel—15 percent of live load moment.

(2) Timber—none.

d. Lateral Distribution Factor. Theoretically, two stringers are twice as strong as one, four are twice as strong as two, and so on. Actually, this is true only if each stringer carries an equal share of the total load. A stringer directly under a wheel load is more highly stressed and carries a greater portion of the load than those farther to the side. Because of this nonuniform lateral distribution of a wheel load among stringers, the total width (or number) of stringers required to carry a particular load is greater than the total width (or number) that would be required if all stringers carried an equal share of the load. This requires an increase in stringer width (or number of stringers) and is expressed as a ratio called *lateral distribution factor.* For design of two-lane military bridges with vehicles on the centerline of each lane, the factor is 1.5.

e. Roadway Widths. A minimum clear width between curbs of 13 feet 6 inches for single-lane bridges and 22 feet for two-lane bridges.

f. Distance between road contacts of vehicles following in line—100 feet.

F–6. Determining Vehicle Class Number in the Office

a. Compute the maximum moment produced by the vehicle in at least six simple spans of different length.

b. Convert maximum moment to SALE using the formula, $SALE = \frac{4M}{L}$, in which $M =$ maximum moment in foot-tons, and $L =$ span length in feet.

c. Plot SALE against corresponding span length.

d. Draw curve through the points plotted. This is the moment class curve for the vehicle.

e. Superimpose the curve over the standard class curves for moment (fig F–7, F–8, and F–9).

f. Determine the class of the vehicle by the position of the vehicle class curve with respect to the standard class curves. Round off any fraction to the next larger whole number.

g. Repeat *c* through *f* above for maximum shear, using the formula, $SALE = shear$.

h. The class of the vehicle is the maximum class determined from either the moment or shear curve. In most cases, moment will govern.

i. Example: Single Vehicle. Figure F–13 shows the moment curve for a 2½ ton, 6x6, dump truck superimposed on the standard class curves. From the figure it is seen that the curve for this vehicle lies between the class 4 and the class 8 curves and from its position with respect to these curves the vehicle is class 8.

j. Example: Combination Vehicle Over Class 40. Figure F–14 shows the moment curve for a M26A1 tractor with transporter M15A1, loaded, superimposed on the standard class curves. From

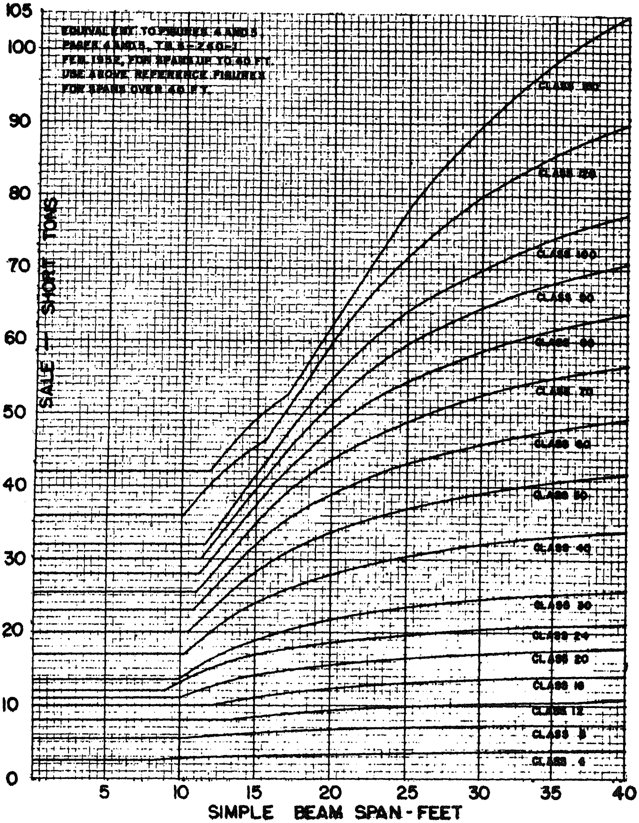


Figure F–8. Standard class curves (moment), 4 to 150 (span 5 to 40).

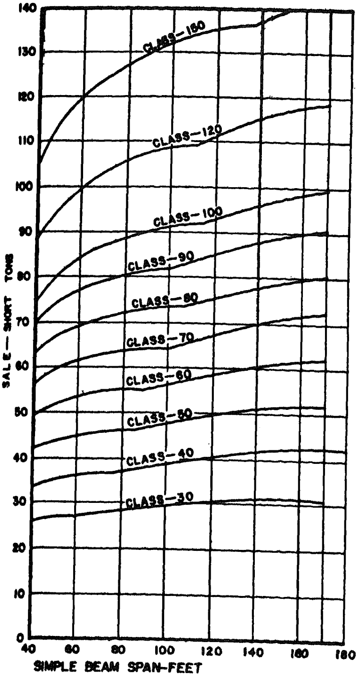


Figure F–9. Standard class curves (moment), 30 to 150.

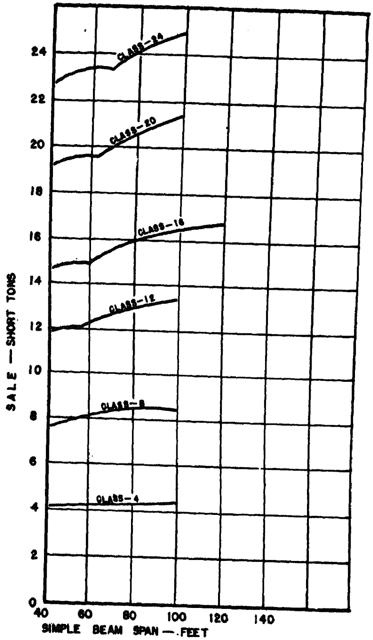


Figure F–10. Standard class curves (shear), 4 to 24.

the figure it is seen that at a span length of 100 feet the superimposed curve crosses the standard class 70 curve and begins to level off. It does not cross the class 80 curve. From its position with respect to the standard class curves, the class of the vehicle is 77. Figure F–14 shows that the vehicle has lower classes at shorter span lengths. At a span length of 70 feet, for example, the vehicle's class curve crosses the standard class 60 curve, and, for this span the class of the vehicle is 60. The other classes of the vehicle for shorter span lengths are similarly determined by inspection of the curves and this information is placed on a cab plate. The section of the cab plate for this vehicle, loaded, shows the following:

Span (ft)	*Class*
0 to 9	60
9 to 12	70
12 to 16	60
16 to 38	50
38 to 70	60
70 to 100	70
100 and over	77

F–7. Determining Vehicle Class Number in the Field

If time, information, or a qualified engineer is not available, and the office methods cannot be used, substitute one of the following methods:

a. Compare characteristics such as dimensions, axle loads, and gross weight with characteristics

Title: SALE FOR SHEAR *Date: June 1952*

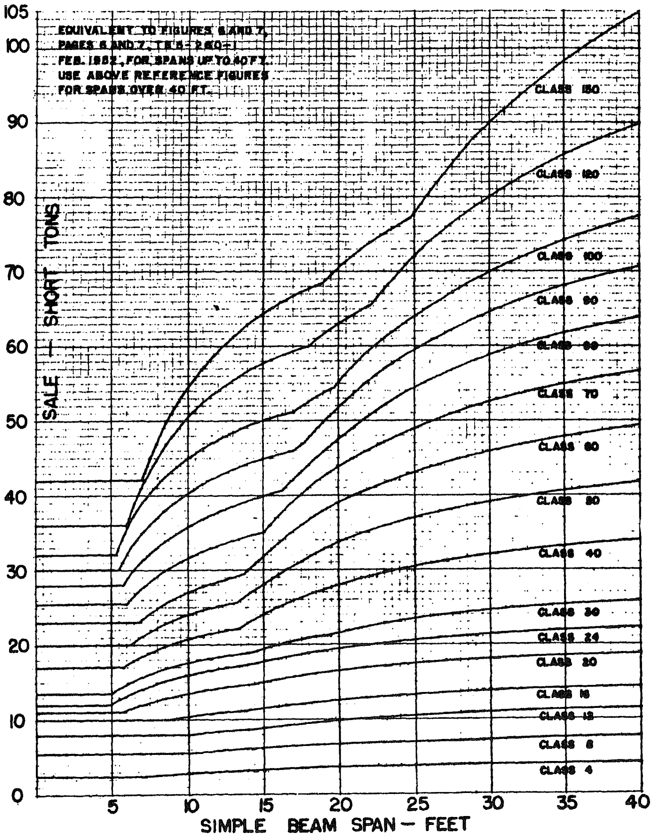


Figure F–11. Standard class curves (shear), 4 to 150 (span 5 to 40).

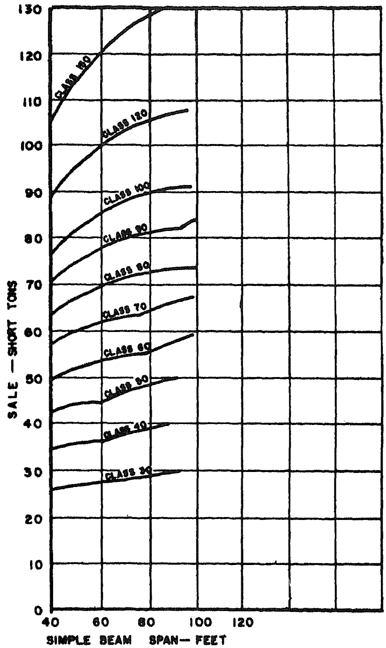


Figure F–12. Standard class curves (shear), 30 to 150.

of the hypothetical vehicles shown in figure F–4. *Example:* An unclassified wheeled vehicle has a gross weight of 27 tons and a length of about 26 feet. By interpolation in figure F–4, it is class 23. If, however, because of axle spacing and weight distribution the maximum single-axle load for this vehicle is 12.5 tons (greater than fig F–4 shows as allowable for class 23) the maximum single-axle load is used as the classifying criterion. By interpolation in the maximum single-axle load column (fig F–4), the vehicle is then class 26.

b. Compare the characteristics of an unclassified vehicle with those of a similar classified vehicle. *Example*: An unclassified single vehicle has three axles, is about 166 inches long, and weighs about 8½tons. By comparison with a standard 2½-ton truck, 6x6, LWB, which weighs 8.85 tons, it is class 8.

c. Compare the ground-contact area of an unclassified tracked vehicle with that of a classified

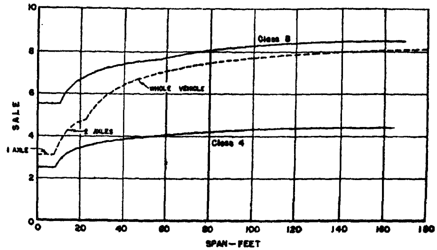


Figure F–13. Moment curve for 2½-ton truck, 6x6, dump, LWB.

tracked vehicle. Tracked vehicles can be assumed to be designed with approximately the same ground pressure. *Example:* An unclassified tracked vehicle has a ground contact area of about 5,500 square inches. By comparison with an M4 tank which has a ground contact area of 5,444 square inches, it is class 36.

d. Compare the deflection in a long steel span caused by an unclassified vehicle with the deflections caused by classified vehicles. In this method the span must be at least twice as long as the vehicles and the vehicles must be placed for maximum deflection. Measuring apparatus must be accurate to at least one thirty-second of an inch. *Example*: Two vehicles of known class are selected which are estimated to bracket the unknown vehicle class. The deflections of a long steel span when loaded individually by each of the three vheicles are measured. Each vehicle is moved one the span three times and the deflection read. The three readings are then averaged.

Vehicle	*Class*	*Deflection (average of three loadings)*
A	62	$2\frac{13}{32}$ in., or 2.406 in.
B	42	$1\frac{11}{16}$ in., or 1.688 in.
C	Unknown	$2\frac{3}{32}$ in., or 2.094 in.

Class is considered proportional to deflection, so—

$$\text{Unknown class} = \text{Lower class} + (\text{Upper class—lower class}) \times \frac{\text{Deflection of unknown class minus deflection of lower class}}{\text{Deflection of upper class minus deflection of lower class}}$$

$$= 42 + (20 \times \frac{2.094 - 1.688}{2.406 - 1.688}$$

$$= 42 + (20 \times \frac{0.406}{0.718}$$

$$= 42 + 11.32 = 53.32, \text{ or class } 53$$

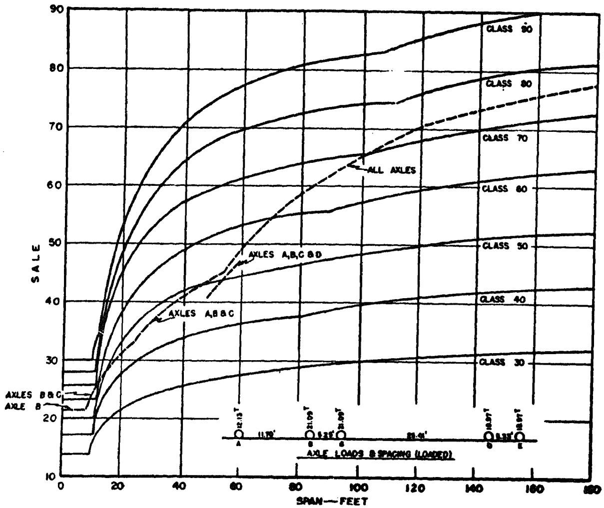


Figure F–14. Moment curve for M26A1 tractor, with transporter, M15A1, loaded.

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By Order of the Secretary of the Army:

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General, U. S. Army
Acting Chief of Staff

Official:
VERNE L. BOWERS
Major General, United States Army
The Adjutant General

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ACSI (2)
DCSLOG (2)
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CONARC (5)
CAR (2)
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COA (1)
CINFO (1)
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USATCFLW (50)
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MAAG (2)
Units org under fol TOE:
5–35 (5)
5–77 (20)
5–78 (5)
5–115 (2)

NG: State AG (3); Units—Same as Active Army.

USAR: Same as Active Army except allowance is one (1) copy to each unit.

For explanation of abbreviations used, see AR 310–50.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1973—509-761/521

Table 2-1. Number of Parts Need

Items	Unit weight (lbs)	Spares included	Number of parts required for b											
			Truss construc											
			Single-single		Double-single					Triple-single				
			Cl											
			(30)[1] 30	(24)	(75) 70	(65) 65	(60) 60	(50) 55	(40) 45	(85) 80	(65) 65	(50) 55	(35) 40	(80)[1] 80
			Span in											
			30	40	50	60	70	80	90	80	90	100	110	100
Bearer, Footwalk	23	2 or 4	16	20	24	28	32	36	40	32	40	46	50	46
Bearing	68	----------	4	4	8	8	8	8	8	8	8	8	8	8
Bolt, bracing	1	25%	20/10	25/15	80/15	95/20	110/20	125/25	140/30	170/25	190/30	210/30	230/35	265/30
Bolt, chord	7.5	10%	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	88/0
Bolt, riband, guardrail, "J"	4.5	10%	62	70	79	88	97	106	114	106	114	123	132	123
Brace, sway, M2	68	10% to 4 max.	7/2	9/4	11/4	13/7	15/7	18/9	20/11	18/9	20/11	22/11	24/13	22/11
Chess, M2	65	10% to 20 max.	100	114	129	143	157	172	186	172	186	200	215	200
Clamp, transom	7	10% to 20 max.	15/4	20/7	99/7	57/9	65/9	73/11	81/13	212/11	125/13	134/13	147/15	180/13
Footwalk	104	2	8	10	12	14	16	18	20	18	20	22	24	22
Frame, bracing	44	10%	-----/-----	-----/-----	11/-----	13/-----	15/-----	18/-----	20/-----	18/-----	20/-----	22/-----	24/-----	46/-----
Panel	577	10% to 10 max.	7/4	9/7	22/7	26/9	31/9	35/11	40/13	53/11	59/13	66/13	73/15	88/13
Pedestal, ramp, M2	93	----------	8	8	8	8	8	8	8	8	8	8	8	8
Pin, panel	6.1	20% to 50 max.	19/5	24/10	58/10	67/14	77/14	86/19	96/24	110/19	125/24	139/24	154/29	202/24
Pin, panel, short	5.8	----------	-----	-----	-----	-----	-----	-----	-----	16	16	16	16	-----
Pin, safety	0.13	25% to 70 max.	20/6	25/10	60/10	70/15	80/15	90/20	100/25	135/20	150/25	165/25	180/30	210/25
Plate, base	381	----------	4	4	4	4	4	4	4	4	4	4	4	4
Plate, tie	3.5	10%	-----	-----	-----	-----	-----	-----	-----	20	22	24	26	-----

Weight per Bay

Construction	Weights Per Bay (tons)
dge	2.76
idge	3.41
idge	4.01
ridge	4.66
ridge	5.88
idge	6.46
ridge	8.29
nching nose	1.00
nching nose	1.64
unching nose	2.90
KING:	
ngers only	0.79
ss and steel ribands	0.66
WALKS	0.17
HEAD BRACING pports, transoms, sway ing, and chord bolts)	0.54
R TREAD AND USS GUARDS	0.35

alks, wear treads, and guards not included. Overbracing included on DT T.

tween plain rollers	25′
plate to	28 5/16″
ting roller	
king roller	16 5/16″
n roller	
ain roller	8 15/16″
p pedestal	17 1/4″
alf round lug under	
top of ramp chess	5 7/8″
to overhead	
	14′7″
	12′3″
ing to bottom	5 17/32″
nel to top of chess	20 11/16″
alf round lug	
hess	22 13/32″
ing roller	
ng roller	13 9/16″

LAUNCHING CONSTRUCTION

Bridge Type	Bridge Span (ft.)	No. of Bays In Nose SS	DS	DD	Distance of Links from Tip of Nose (ft.)	Required Distance Behind Rocking Rollers (ft.)
SS	30	2			—	35
	40	3			—	43
	50	3			—	47
	60	4			10	55
	70	5			20	63
	80	5			20	67
	90	6			30	75
	*100	*6			30	76
DS	50	3			—	45
	60	4			10	52
	70	4			10	57
	80	5			20	64
	90	6			20	71
	100	6			20	76
	100	7			30	83
	120	8			40	90
	130	8			10 & 40	95
	*140	*8			10 & 40	96
TS	80	5			20	63
	90	6			20	70
	100	6			20	74
	110	7			30	81
	120	7			30	86
	130	8			40	93
	140	9			10 & 40	100
	*150	*9			20 & 40	101
	*160	*9			20 & 40	106
DD	100	6			20	74
	110	7			20	81
	120	7			30	86
	130	8			30	93
	140	7	2		40	100
	150	6	3		40	106
(*)	*160	*6	*3		40	106
	*170	*7	*3		10 & 40	113
	*180	*7	*3		20 & 40	117

Bridge Type	Bridge Span (ft.)	No. of Bays In Nose SS	DS	DD	Distance of Links from Tip of Nose (ft.)	Required Distance Behind Rocking Rollers (ft.)
TD	110	6			20	77
	120	7			20	84
	130	6	2		30	90
	140	5	3		30	96
	150	5	4		40	103
	*160	*5	*4		40	106
	*170	*6	*4		10 & 40	112
	*180	*7	*4		10 & 40	125
	*190	*7	*4		20 & 40	126
DT	130	5	3		30	91
	140	5	3		30	96
	150	5	4		30	102
	160	5	5		40	109
	*170	*5	*5		40	112
	*180	*5	*5		40	116
	*190	*6	*6		10 & 40	131
	*200	*7	*5		20 & 40	132
	*210	*7	*5		30 & 40	135
TT	*160	*5	*5		40	94†
	*170	*5	*6		40	96†
	*180	*6	*5	*2	40	102†
	*190	*6	*6	*2	10 & 40	112†
	*200	*6	*6	*4	20 & 40	115†
	*210	*7	*5	*6	30 & 40	117†

*Spans launched incomplete. See adjacent table.

† Estimated.

SPANS LAUNCHED INCOMPLETE

Type	Span (ft.)	No. of Bays Decking & Stringers	Omitted of Top Story
SS	100	4	
DS	140	6	
TS	150	6	
	160	10	
DD	160	7	
	170	7	
	180	12	2
TD	160	3	
	170	10	
	180	All	
	190	All	3½
DT	170	3	
	180	8	
	100	All	
	200	All	3
	210	All	5
			No. of Bridge Bays in Initial Construction[1]
TT	160	3	14
	170	6	14
	180	6	14
	190	All	15
	200	All	14
	210	All	13

[1] First 3 bridge bays are constructed DT with only 1 transom per bay. Last bridge bay is constructed DT because of staggered construction necessary when adding subsequent bays.

LAUNCHING BRIDGES 1. Launch until near-bank rocking rollers are under last TT bay of initial construction. 2. Add up to 6 bays TT to tail of initial construction. This completes all but 210-foot span. 3. Continue launching until near-bank rocking rollers are under last TT bay added in step 2. 4. Add remainder of TT bays to complete bridge (210-foot span only). 5. Add 5 bays DS nose-type construction to tail of bridge. 6 Launch forward until first 3 DT bridge bays are beyond far-bank rollers. 7. Complete first 3 bridge bays by converting to TT and adding transoms. 8. Pull bridge back to final position, remove DS tail, add decking where needed, and jack down.